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US006047652A

United States Patent [19]

Prairie et al.

[11] Patent Number: 6,047,652

[45] Date of Patent: Apr. 11, 2000

[54] SEED PLANTER DISTRIBUTION SYSTEM

[75] Inventors: Douglas Samuel Prairie; Bradley John Meyer; Timothy Allen Murray; Eugene Irving Breker, all of Fargo, N. Dak.

[73] Assignee: Case Corporation, Racine, Wis.

[21] Appl. No.: 09/076,225

[22] Filed: May 12, 1998

[51] Int. Cl.[7] A01C 7/00

[52] U.S. Cl. 111/174; 406/146; 406/124; 406/181; 406/41

[58] Field of Search 111/170, 171, 111/174, 175, 176, 177; 406/141, 142, 143, 146, 124, 120, 181, 41; 222/630, 195

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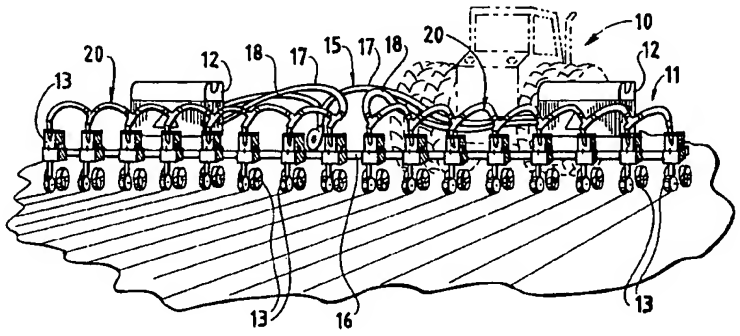
Primary Examiner—Victor Batson

Attorney, Agent, or Firm—Richard A. Speer; Mayer Brown & Platt

[57] ABSTRACT

A seed planter distribution system for transporting seeds from a source into a plurality of seed metering bins, the system including a manifold duct and a plurality of seed flow diverting structures that extend from the manifold into each metering bin, whereby each metering bin is filled in accordance with the flow of air available thereto.

12 Claims, 3 Drawing Sheets



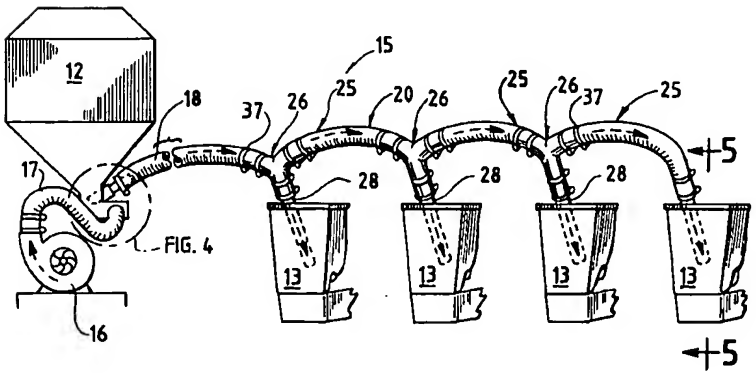


FIG. 4

FIG. 1

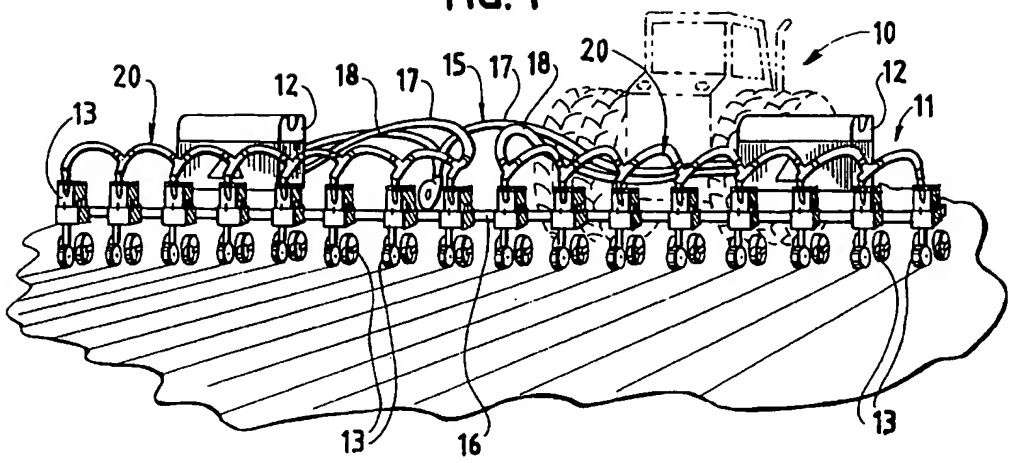

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FIG. 2

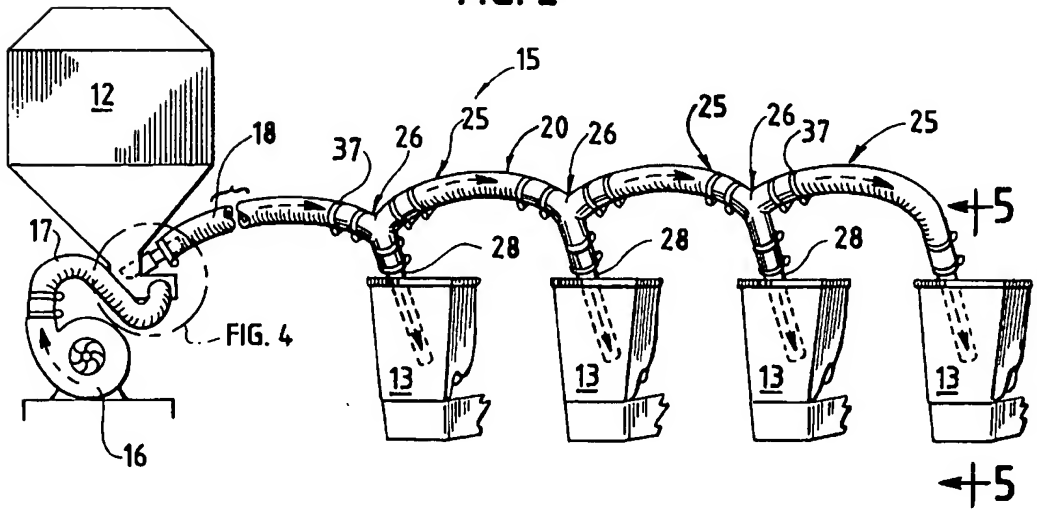
15
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FIG. 4
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FIG. 3

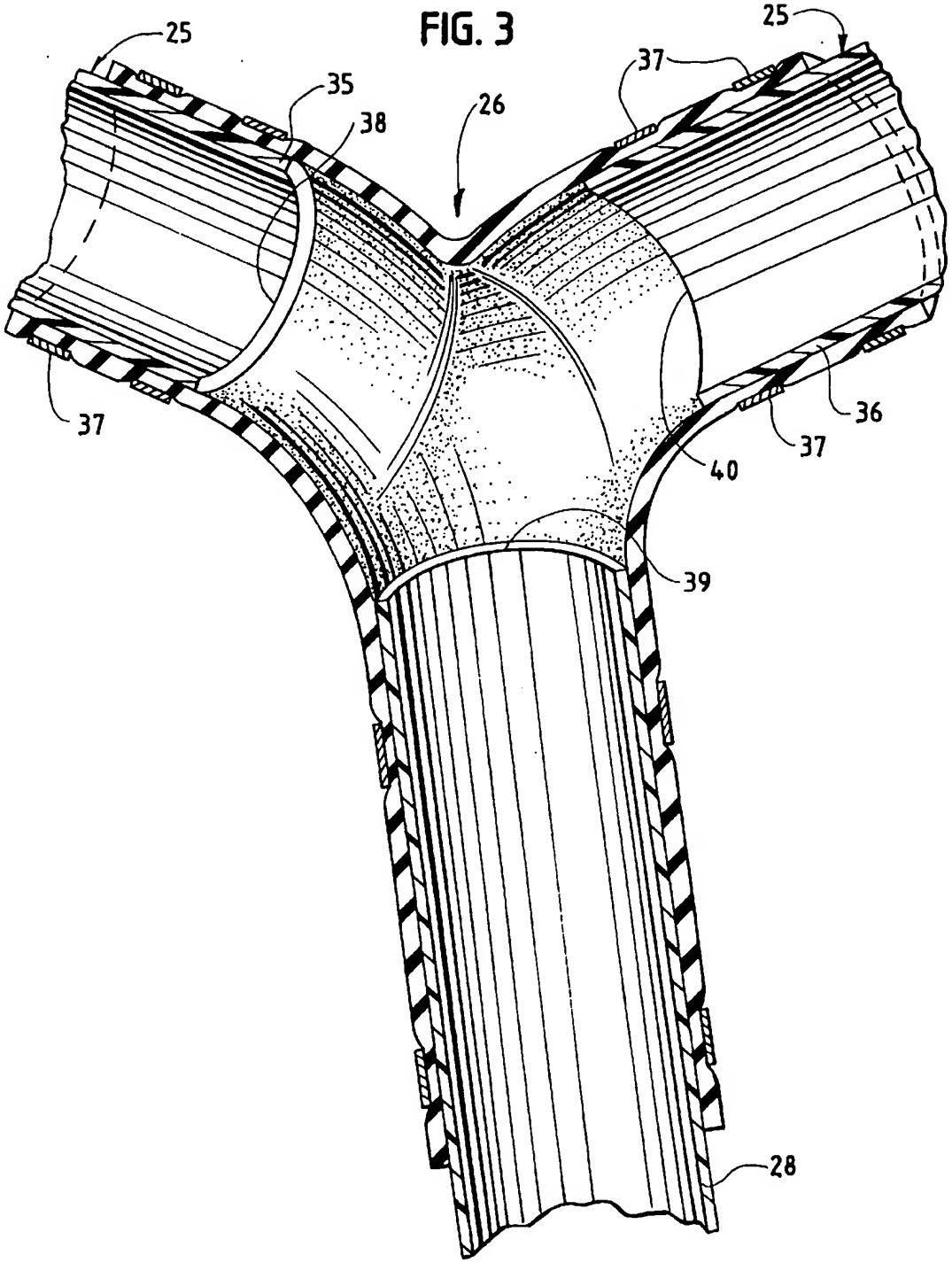


FIG. 4

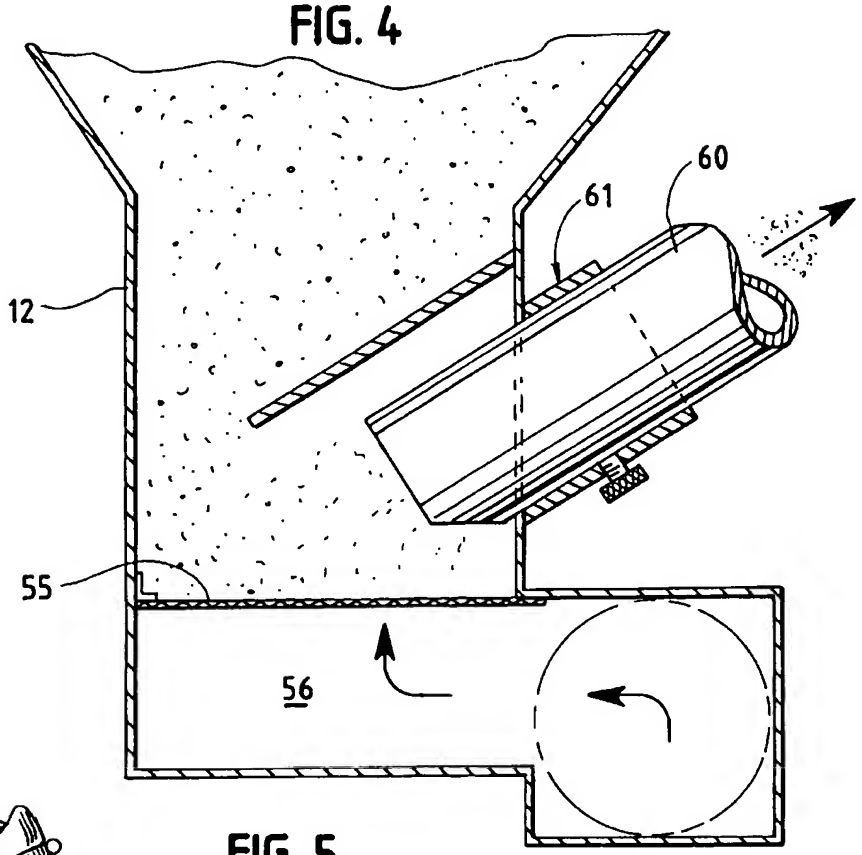
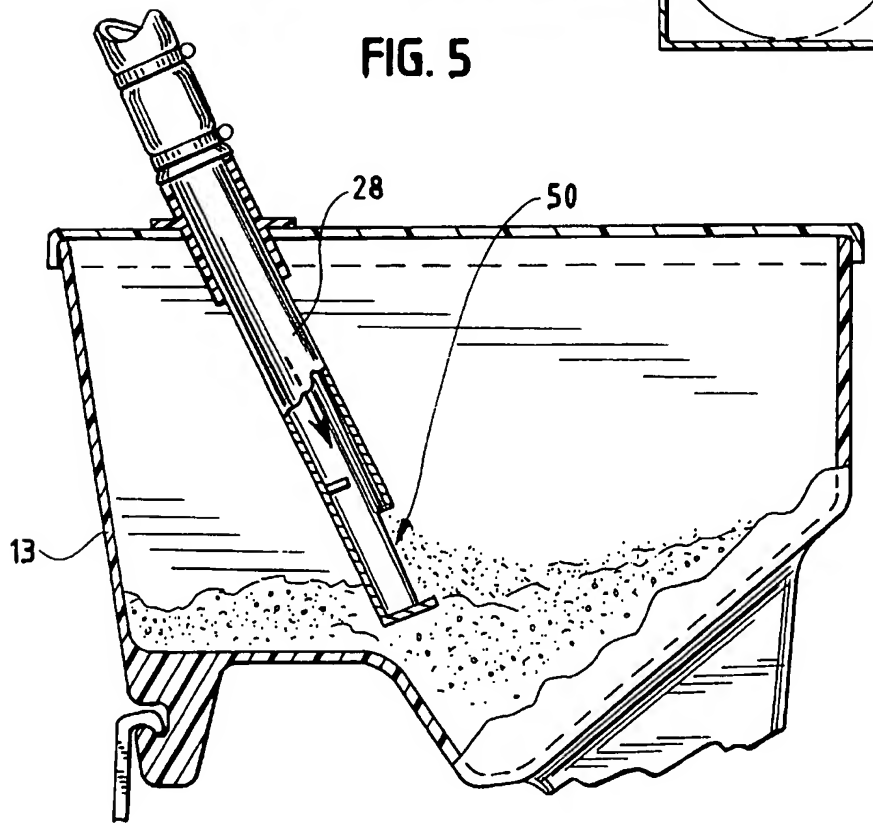


FIG. 5



SEED PLANTER DISTRIBUTION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is concerned generally with agricultural implements and more specifically to an improved apparatus and method for transferring agricultural seed or other particulate material from a principal storage site to individual material metering hoppers mounted on planters, grain drills and the like.

2. Background

In the past, distribution of seed (or other particulate material such as fertilizer) for use in a variety of agricultural operations has been effected with the use of a plurality of row dispensing bins each of which has an associated metering device for applying pre-selected quantities of the seed or other particulate material to the land. These individual bins generally had limited storage capacity, for example 1 to 3 bushels and therefore required frequent refilling, which filling, if is effected from a fixed storage tank site, increased the overall planting time. Subsequent in time, the "down" time that occurred because of the use of fixed site storage tanks was basically eliminated by the development of apparatus in which a central supply of material was carried on the mobile equipment so that the dispensing bins could be resupplied with material during operation in the field. A seed distribution system in which grain is conveyed from an equipment-mounted main hopper can be seen in U.S. Pat. No. 5,161,173 issued Nov. 10, 1992 and assigned to Deere and Company. This system utilizes a single main hopper which dispenses seed to a plurality of individual or mini-hoppers that each, in turn, supply seed to an individual planting row. The seed is fed from the main hopper into each mini-hopper by entraining it in an airstream contained in separate, individual transfer hoses that are connected between the main tank and each of the individual mini-hoppers.

U.S. Pat. No. 5,379,706, issued Jan. 10, 1995 and assigned to Agco Corporation, is illustrative of another seed transporting system which also utilizes a central storage hopper for supplying a plurality of smaller, satellite hoppers via a plurality of individual hoses or tubes running from the central hopper to each of the individual satellite, row hoppers. Thus, while the systems of the 'BM73 and '706 patents provide for the maintenance of seed supply quantities in the row hoppers during seeding operations, they also require the incorporation of a large number of separate seed transport tubes in those systems where multiple, mini-hoppers are present. Since the requirement that multiple, individual seed feeding tubes to supply the dispensing hoppers may involve higher initial equipment costs and also increased maintenance costs, a more efficacious system would be one where the seed supply tube from the main tank are kept to a minimum.

BRIEF SUMMARY OF THE INVENTION

Whereas previously existing agricultural seed distribution systems for filling individual row seed bins have involved the use of individual supply hoses that extend from the seed source to each row bin, the present invention is designed to provide delivery of preselected quantities of seed to the separate row bins by means a single manifold transfer duct. The manifold duct is connected to a seed supply source at one end and has a plurality of flow diverting means located at predetermined, serial locations along its length. Each flow diverting means is connected to the interior of the manifold duct and extends downwardly into an underlying row bin to deliver seed from the duct to the bin. Advantageously, the manifold duct is constructed of sections which are joined end to end by the flow diverting means and the sections are each curved so that when assembled the mid-portion of each section is located vertically higher from the distribution bins than are its ends. When seed is pneumatically introduced into the manifold duct from the main supply hopper during planting operations, it initially flows through the first manifold section in an upwardly directed path and then downwardly toward the first flow diverter and on into the first of a series of row bins. The generally curved shape of each section comprising the overall manifold duct create a somewhat sinuously shaped flow path having upper and lower nodes, the lower nodes being located at each diverter location. After the seed in the first row bin reaches some desired level, which level can be varied, the outlet end of the flow diverter becomes blocked by the seed and the air borne seed in the manifold duct is caused to flow onward to a second distribution bin. In this manner, each seed distribution bin is filled in sequence until all are filled, thereby causing interruption of air and seed flow from the source. At any time the level of the grain in the distribution bins drops low enough to again permit air flow, the bins will automatically receive additional grain.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration showing how the material transporting apparatus of this invention is used in conjunction with agricultural equipment;

FIG. 2 is a schematic view showing the present apparatus design for transporting material from a supply bin to separate distribution bins;

FIG. 3 is an enlarged sectional view of a flow diverter;

FIG. 4 is partial sectional view of a portion of the supply bin showing how material is directed into the transport system; and

FIG. 5 is a side view, partially sectioned, illustrating the disposition of the outlet of a material diverter means in a distribution bin.

DETAILED DESCRIPTION

For a more complete understanding of the invention, reference is made to the drawings and initially to FIG. 1, which shows the pneumatic seed transporting system of this invention as it would be used in conjunction with an agricultural planter or seeder. In FIG. 1, numeral **10** indicates an agricultural tractor to which a planter **11** may be connected for transport through a field. The planter or seeder **11**, is shown as having two central storage or reservoir hoppers **12** and a plurality of individual distribution or row metering hoppers **13** that receive seed from the storage hoppers **12** by means of a distribution system indicated generally by the numeral **15**. Generally speaking, central storage tanks **12** could have capacities ranging from 50 to about 340 bushels while the individual row bins would characteristically range from about 1 quart BM to 3 bushels in capacity. Each of the row metering bins **13** will have an associated seed metering device that applies the seed to the soil in a manner well-known in the art. Each seed transport duct **18** is connected to supply seed up to twelve individual row hoppers, so that in FIG. 1 the planting system is capable of sowing seed in twenty-four rows. However, each storage tank **12** can house up to 4 transport ducts **18**. The ability of the present system to supply seed to a comparatively large number of row bins, up to 48 per tank, is facilitated by the

design of a single seed transport duct that is connected to a hopper **12** at one end and which extends from there outwardly over a series of row bins. The delivery system includes a source of air, such as blower **16**, that is connected by air supply tubes **17** to the bottom of storage hoppers **12**. Air entering into the hopper **12** picks up seeds and pneumatically transports them through tubes **18** into the inlet ends of a manifold supply duct **20**, as shown in FIG. **4** and discussed below.

Referring now to FIG. **2** of the drawings it can be seen that the manifold duct **20** is comprised of a series of sections **25** that are joined at the inlet and outlet end of each section by seed flow diverting means **26**. Sections **25** are configured in such a way that the midsection of is each section is located at an elevation that is further above the row bins **13** than are the ends thereof so that the outlet end of each section extends in a downward direction into the inlet **38** of a seed flow diverter **26** of generally Y-shaped configuration. Diverter **26** has a downwardly directed outlet **39** that can be used with a bin feed tube **28** which extends into the interior of the bins for the flow of seeds there into and diverter **26** has a second outlet opening **40** which extends upwardly for connection into the inlet side of the succeeding manifold section **25**. (See. FIG. **3**)

As best seen in FIG. **3**, the Y-shaped diverter **26** is shown connected the outlet end **35** of a manifold section **25** and to the inlet end **36** of the following manifold section **25**. The connection of diverter **26** to the outlet end **35** and inlet end **36** can be made with suitable fasteners such as hose clamps **37**. Because of the diverter **26** configuration, it has an inlet opening **38**, first outlet opening **35** and a second outlet opening **40**, as set out above. As seed flows through the manifold section shown on the left in FIG. **3**, it initially passes through the high point or upper node of the section **25** and then flows downwardly toward the outlet end **35** and into the inlet opening **38** of diverter **26**. The shape of the diverter directs seed flow straight down into the outlet opening **39** and into bin feed tube **28**. At the beginning of the bin filling operation virtually all of the seed coming from a hopper **12** will flow into the initial row bin, since the direction of seed flow in diverter **26** is towards opening **38**.

Each of the manifold sections **25** is shaped in such a way that the mid portion of the section located between the inlet and outlet ends is located elevationally higher from the bins than are either the inlet or the outlet end. That is, the overall configuration of the manifold duct forms a defined passage that is roughly sinuous so that the intermediate portion of each section **25** defines a relatively higher node and the diverting means **26** which connects the outlet end of one section to the inlet section of the following section defines a relatively lower node in the passage. By providing an upwardly curved configuration in each section, material that is being advanced through the manifold **20** approaches the diverter means **26**, in each instance, in a downwardly direction so that it will be caused to continue to flow downwardly into one of the underlying bins **13**.

The diverter means **26** would usually include a bin filler tube **28** which extends downwardly into the associated bin and which may be adjusted as to how far into the bin they extend, in order that the quantity of seed introduced in the bin can be varied. That is, more or less seed can be caused to be placed into a bin, depending upon the quantity chosen by the operator to be sufficient in a particular application. FIG. **5** of the drawings shows the manner in which bin filler tube **28** can be located within the metering feed bin **13**. Specifically tube **28** extends adjustably into the bin through the top thereof, the particular location not being of any particular significance and the seed flows into the bin through the opening **50**. After sufficient seed grain has entered into the bin, the orifice or outlet opening **50** will become blocked by seed and further entry of seed into that bin will continue until seed reaches diverter **26**. By adjusting the position of opening **50** either higher or lower within the bin **13**, either greater or lesser quantities of stored grain can be held within each of the metering bins **13**.

FIG. **4** of the drawings is an enlargement of the area encircled in FIG. **2** of the drawings, illustrating one means by which agricultural seed can be entrained by air and entered into the inlet opening of the first arcuate section **25** of manifold **20**. In this drawing duct **17** is connected to the blower **16** (see FIG. **2**) at one end and at the other end to the interior of hopper **12**. The seed is held within the hopper **12** above screen or other foraminous material **55** which separates it from the air chamber **56** so that air can blow upwardly and entrain the grain and cause it to flow out the duct **18** and on into the first manifold section **25**. Seed above screen **55** enters adjustable outlet tube **60** by means of the air flowing from blower **16** and through the screen. The distance at which the lower end of tube **60** is located with respect to screen **55** can be adjusted by the collar and nut arrangement **6** and the quantity of seed being entrained in the air varied proportionally.

In operation, the user of the present seed feeding apparatus will connect the inlet end of the first section **25** of the manifold structure **15**, previously described, to a source **12** of agricultural seed. This source may either be stationary or carried on the planting apparatus, depending upon the user's preference. During the filling operation, the seed initially exits the storage container, for example, that identified as numeral **12** in the drawings and flows upwardly through the upper node or high point of a section **25** and then downwardly through the outlet exit end **35** of section **25** and through the first diverter means **26** into the first of the metering bins **13**. After the first bin has become filled with grain and the grain has reached the bottom of first diverter **26**, the air flow within which the seed is entrained will be carried outwardly through the other exit opening **40** of the first diverter **26** and into the inlet side of second section **25**. Thereafter the filling process that occurred with respect to the first metering bin is repeated in the second metering bin until it is also filled. The identical operation will take place sequentially as each of the bins is filled until the last of the bins in the series is filled at which time no more grain is conveyed from the source to any of the bins. As grain is dispensed from the metering bins and an opening is no longer blocked by seed in the bin, air flow then resumes and the bin will be continuously refilled with the preselected quantity of seed.

The embodiments of the invention described and shown above are intended by way of example and are not intended to be limiting, as it will be apparent to those skilled in the art that various modifications can be made to the present invention without departing from spirt and scope of the invention.

What is claimed is:

1. Apparatus for pneumatically transporting agricultural seed from a source of air and seed into individual seed metering bins, the apparatus comprising:

(a) manifold duct structure of extended length having an intake opening to receive air borne seed from a source thereof, the duct being comprised of a plurality of interconnected curved duct sections; and

(b) seed diverter structure interconnecting ends of the manifold duct sections, each diverter structure having a

storage bin outlet and being configured to direct the air and seed from the manifold duct sections downwardly into the metering bins.

2. An apparatus as defined in claim 1 wherein each manifold section is shaped so that the ends thereof are vertically nearer to a metering bin than is the length of the section located between the ends.

3. Apparatus as defined in claim 1 wherein the seed diverter structure is configured to receive seed from a preceding manifold section and to direct it downwardly into an associated metering bin and into a following manifold section.

4. Apparatus as defined in claim 1 wherein the seed flow diverter structure includes a metering bin filler tube having an outlet end located within a metering bin.

5. Apparatus for pneumatically transporting agricultural seed from a source of air and seed into individual metering bins, the apparatus comprising:

(a) manifold duct structure comprised of a plurality of curved sections, each section having an inlet and an outlet end;

(b) seed flow diverter structure operably connecting successive ones of the curved sections to form a continuous manifold length, each flow diverter structure having an inlet opening to receive seed flow from a preceding manifold section and having an outlet opening for directing seed into a subsequent manifold section and into a metering bin.

6. Apparatus as defined in claim 5 wherein the seed flow diverter structure has at least three legs wherein a first leg is operably connected to a preceding manifold duct section to receive seed therefrom, a second leg is operably connected to a subsequent manifold duct section to pass seed thereunto and a third leg extends downwardly from a location intermediate the first and second legs into a metering bin.

7. Apparatus as defined in claim 6 wherein the flow diverter structure is of generally Y-shaped configuration.

8. Apparatus for pneumatically transporting agricultural seed from a source of air and seed into individual metering bins, the apparatus comprising:

(a) a central seed supply hopper.

(b) a plurality of individual metering bins mounted on an agricultural implement for movement through a field;

(c) manifold duct structure connected at an inlet end into the seed and air source and extending outwardly therefrom in a position generally above the metering bins, the duct being comprised of a plurality of interconnected curved duct sections;

(d) seed flow diverter structure interconnecting ends of the curved duct sections at locations above the metering bins.

9. In a process for the sequential filling of seed metering bins mounted on an agricultural seeding implement, the steps comprising:

(a) providing a source of seed and air;

(b) providing manifold duct structure that is operably connected to the seed and air source;

(d) providing seed diverter structure in the manifold duct structure at locations immediately above the metering bins, which diverter structure permits transports of seed through a manifold duct structure and into the bins;

(c) pneumatically transporting seed from the source through the manifold duct structure to fill a first metering bin with seed to a level that the seed diverter structure to the first bin is blocked;

(e) continuing the pneumatic transport of seed to fill sequentially each of the seed bins following the first bin by sequential blockage of each subsequent seed flow diverter structure.

10. In the process for the sequential filling of seed metering bins mounted on an agricultural seeding implement, the steps comprising:

(a) providing a seed transfer manifold duct system having a single elongated manifold duct extending above metering bins and a plurality of bin filler tubes that extend downwardly from the elongated manifold duct into an interior of each metering bin;

(b) providing a source of air and seed; and

(c) creating a flow of air entrained seed in the manifold duct system, whereby each metering bin is filled in sequence.

11. Conveying apparatus for use in transporting agricultural seed from a central supply hopper to a plurality of seed metering bins, said apparatus comprising:

(a) an elongated manifold duct having a sinuous shape whereby seed is transported in a downward direction at locations spaced along the length of the duct; and

(b) a grain feed tube operably connected to the manifold duct to direct the seed into a metering bin.

12. In an agricultural implement for distributing agricultural seed, the combination comprising:

(a) a central seed storage hopper;

(b) a plurality of metering bins to receive seed from the central seed storage hopper;

(c) a single, sinuously shaped manifold duct operably connected to the central storage hopper to receive seed therefrom, the manifold duct having relatively higher and relatively lower nodes wherein each lower node is located above an underlying metering hopper;

(d) a seed feed tube connected into each lower node to direct seed into the interior of an underlying metering bin; and

(e) a source of air operably connected to the central storage hopper to transport seed from the storage hopper and through the manifold duct.

* * * * *

US006516733B1

(12) **United States Patent**
Sauder et al.

(10) **Patent No.: US 6,516,733 B1**
(45) **Date of Patent: Feb. 11, 2003**

(54) **VACUUM SEED METER AND DISPENSING APPARATUS**

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(73) Assignee: **Precision Planting, Inc.**, Tremont, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/683,411**

(22) Filed: **Dec. 21, 2001**

(51) **Int. Cl.**[7] **A01C 7/00**
(52) **U.S. Cl.** **111/180**; 111/186; 221/211; 221/278
(58) **Field of Search** 111/177, 178, 111/179, 180, 186, 903, 200, 181, 182; 221/211, 278

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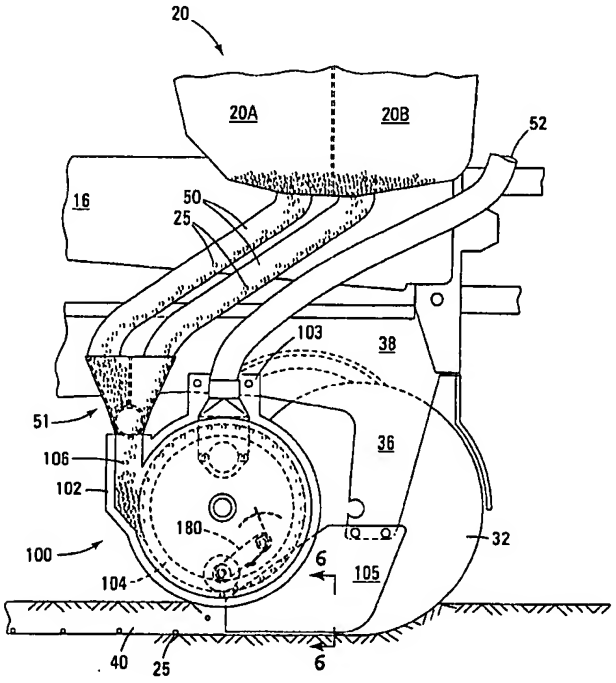
Primary Examiner—Victor Batson
(74) *Attorney, Agent, or Firm*—Larkin, Hoffman, Daly & Lindgren, Ltd.; Thomas J. Oppold

(57) **ABSTRACT**

An agricultural seed planter and seed meter therefore, wherein the seed meter includes a rotary vacuum drum disposed within a stationary housing to entrain individual seeds on an annular circumferential periphery of the drum. As the entrained seeds rotate with the drum the seeds are singulated before being released from said vacuum drum. The seed metering and dispensing device is adapted to be mounted below the seed hopper to discharge the seeds into a seed tube as is conventional, or alternatively the seed metering and dispensing device is preferably adapted for mounting just above the soil surface and between the furrow opening assembly and furrow closing wheel assembly of a conventional agricultural planter such that the seeds are deposited directly into the seed furrow.

52 Claims, 9 Drawing Sheets



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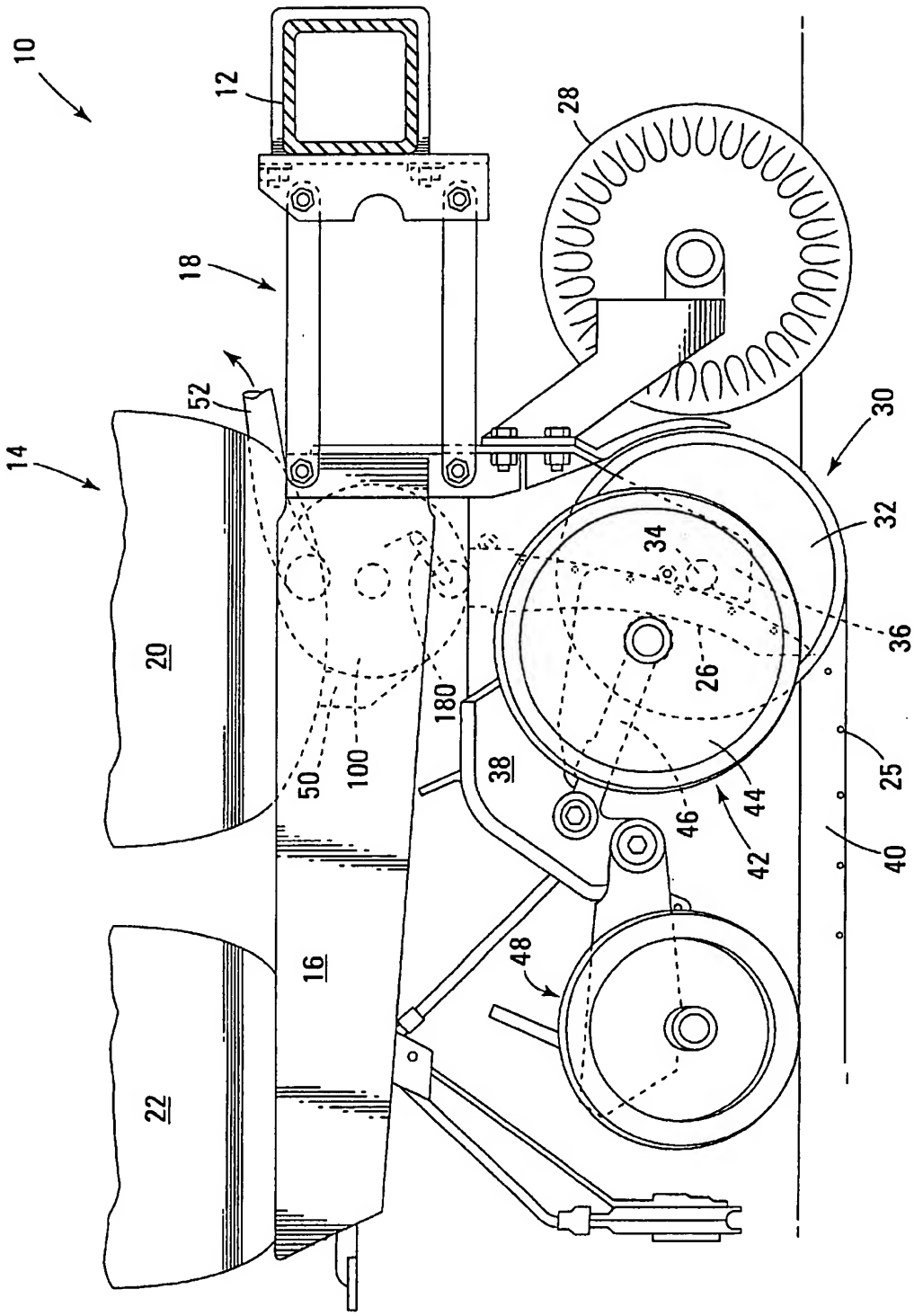
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36
20
26
180
38
25
50
100
44
46
42
40
16
48
22

FIG. 1

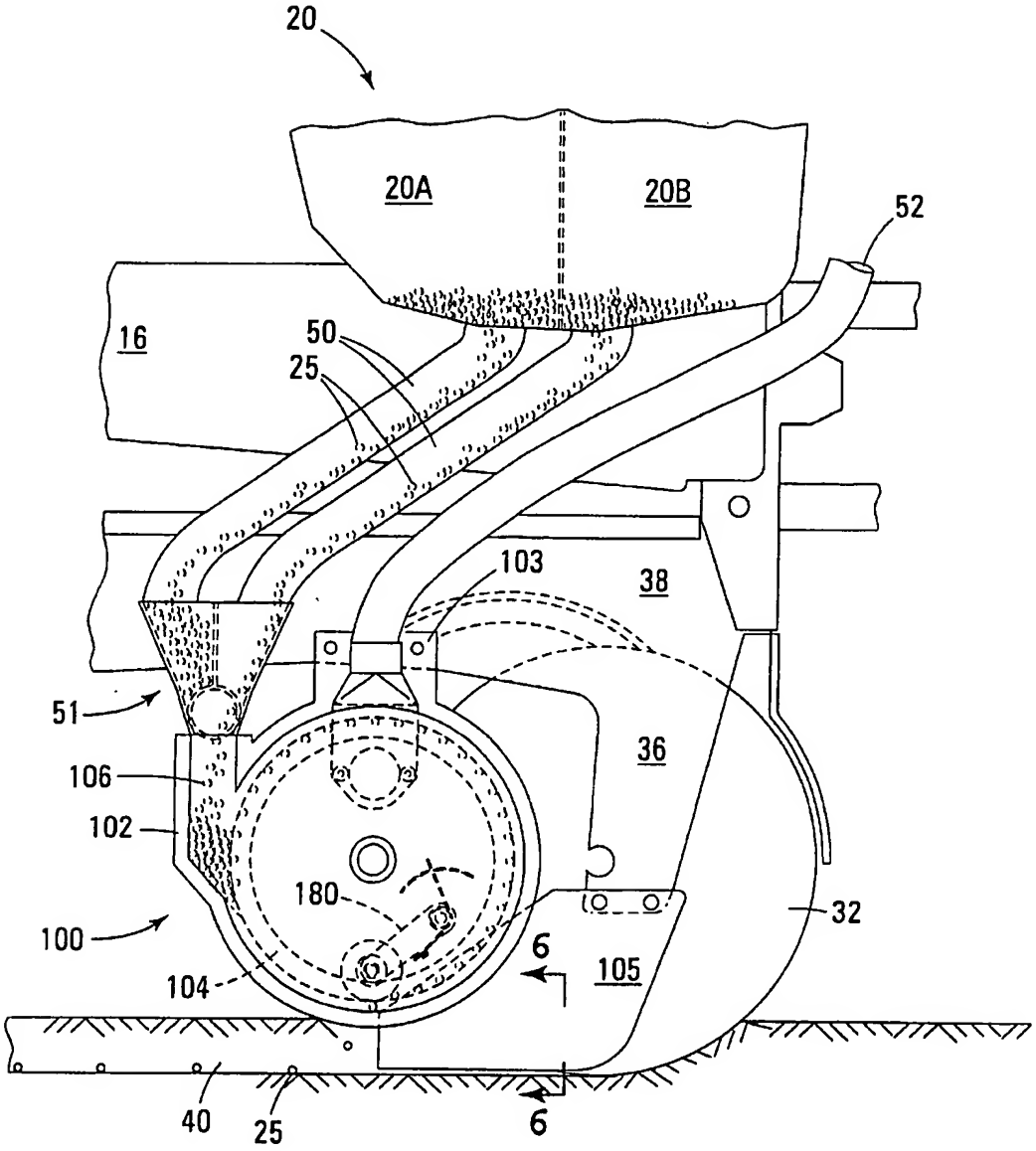
20
20A
20B
52
16
50
25
103
38
51
36
106
102
180
32
100
6
105
104
40
25
6

FIG. 2

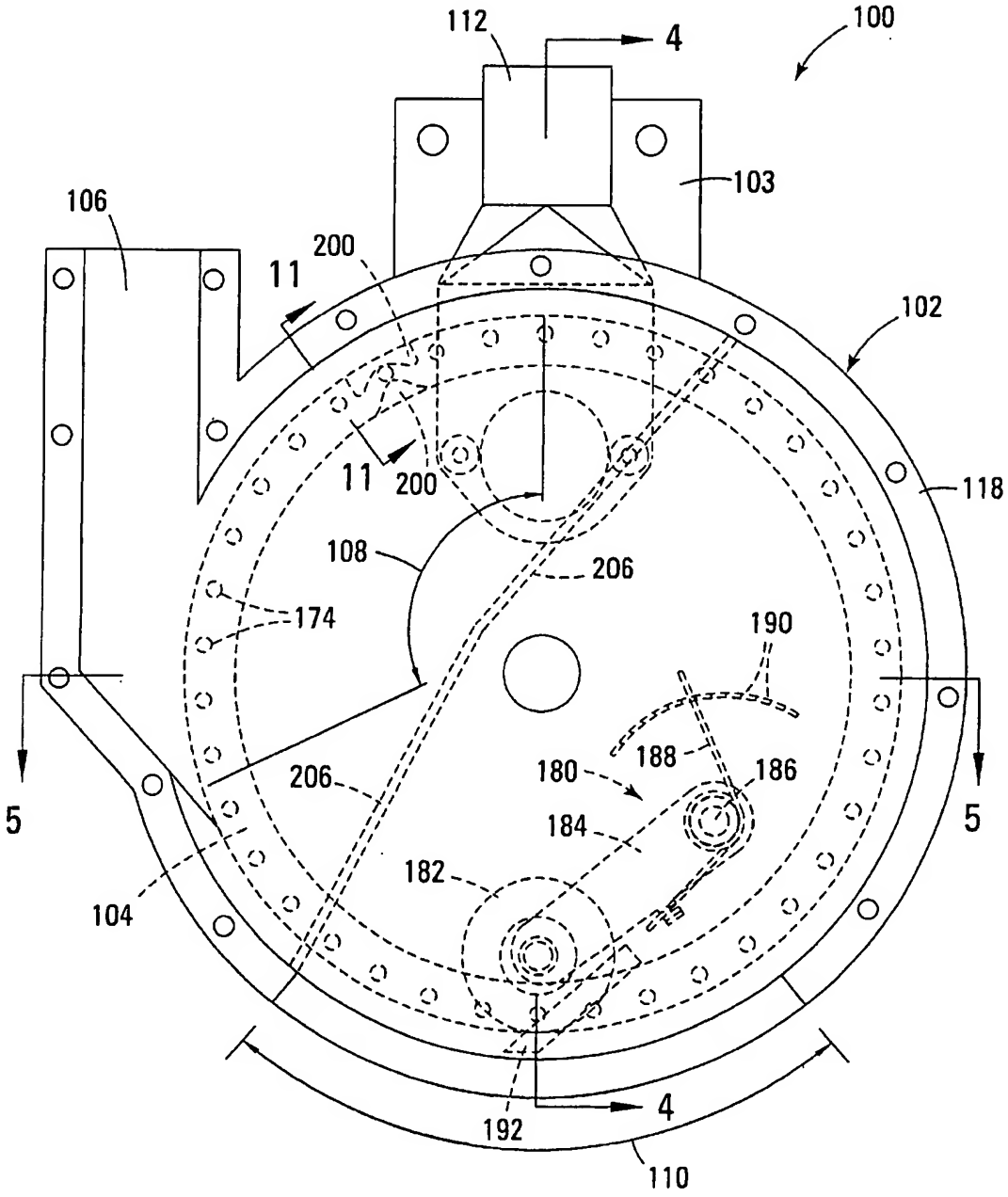
112
4
100
103
106
200
11
102
11
200
118
108
206
174
190
206
180
188
186
184
182
104
5
5
4
192
110

FIG. 3

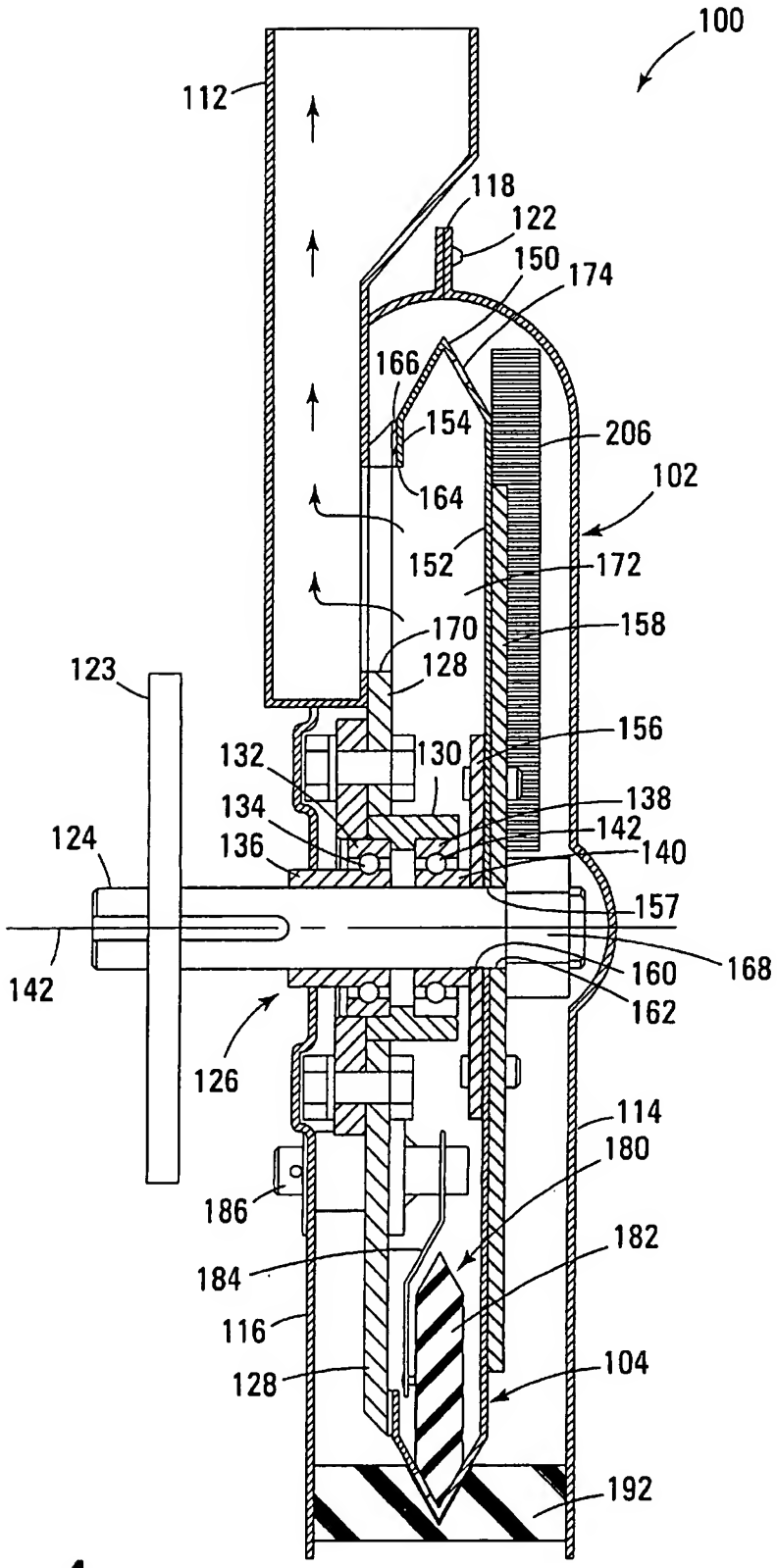
100
112
118
122
150
174
166
154
206
102
164
152
172
170
158
123
128
156
132
130
138
134
142
124
136
140
157
168
142
160
162
126
114
180
186
182
184
116
104
128
192

FIG. 4

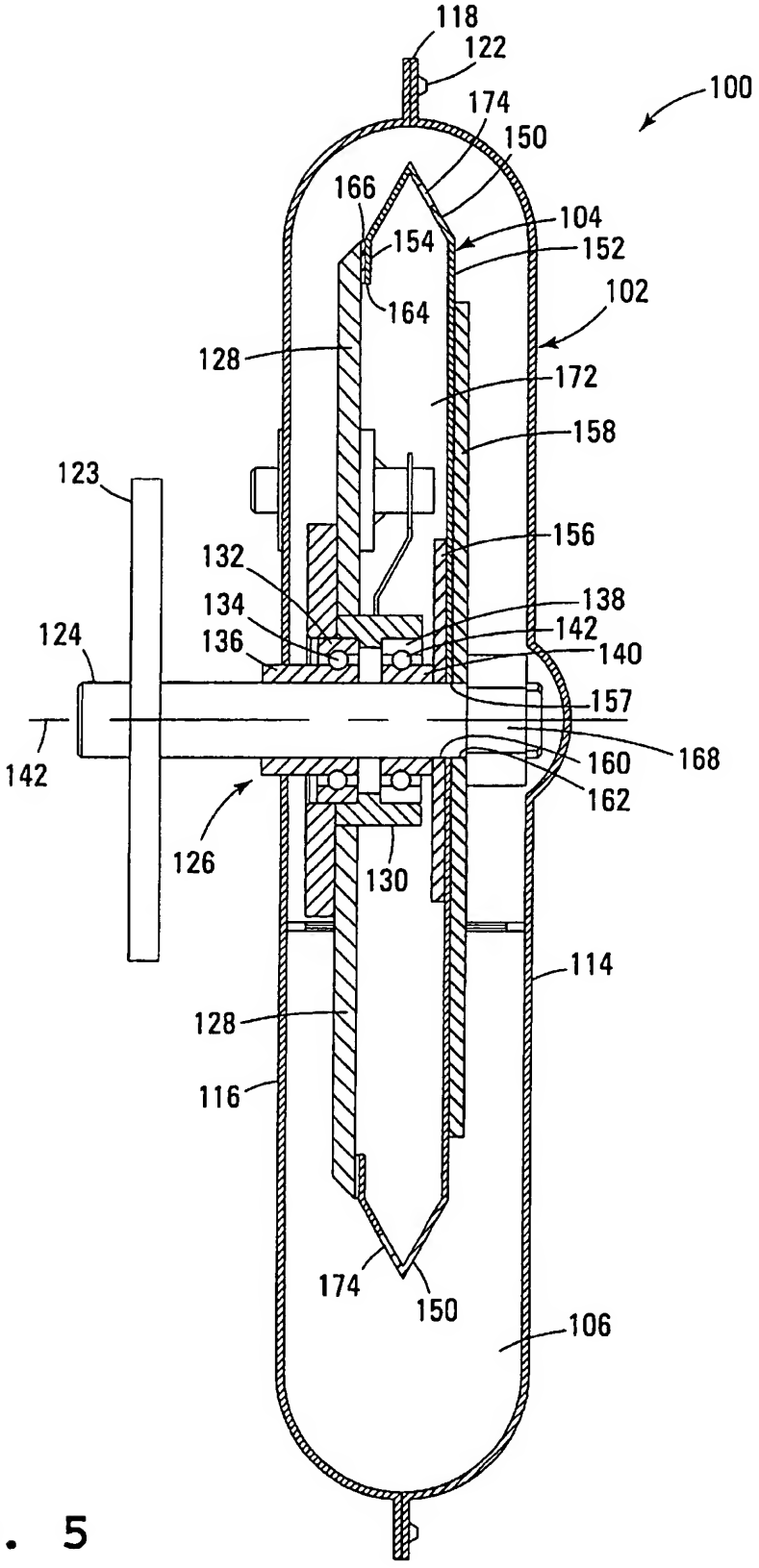
118
122
100
174
150
166
104
154
152
164
102
128
172
158
123
156
132
138
134
142
124
136
140
157
142
160
168
162
126
130
114
128
116
174
150
106

FIG. 5

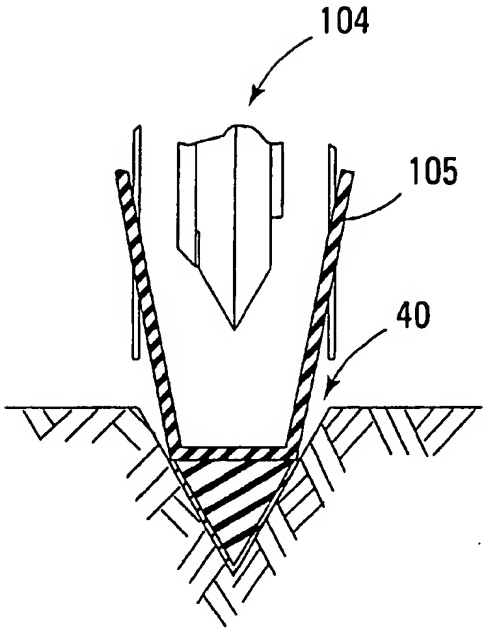

FIG. 6

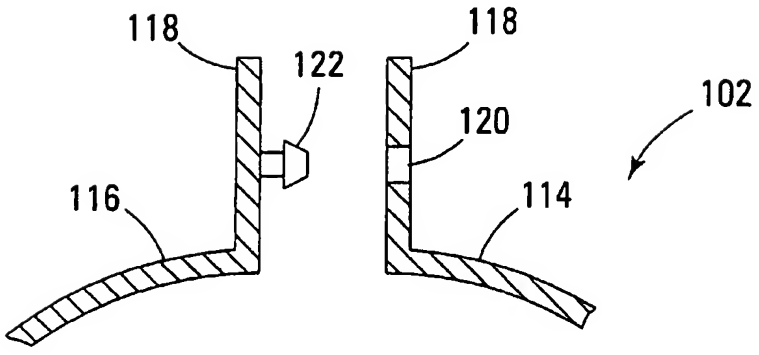

FIG. 7

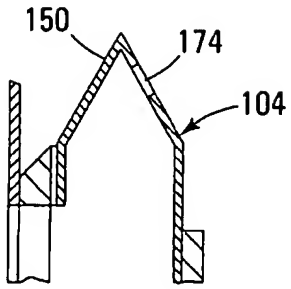

FIG. 8A

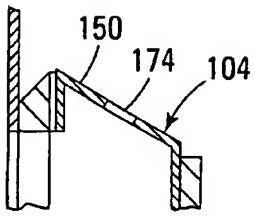

FIG. 8B

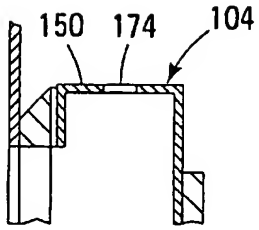

FIG. 8C

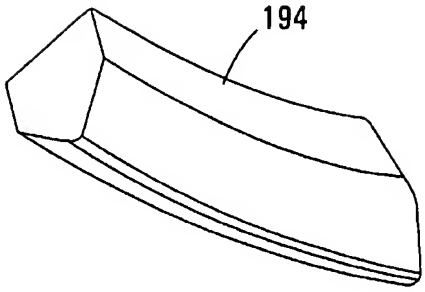

FIG. 9A

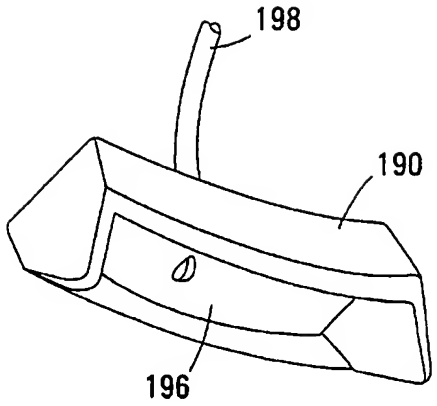

FIG. 9B

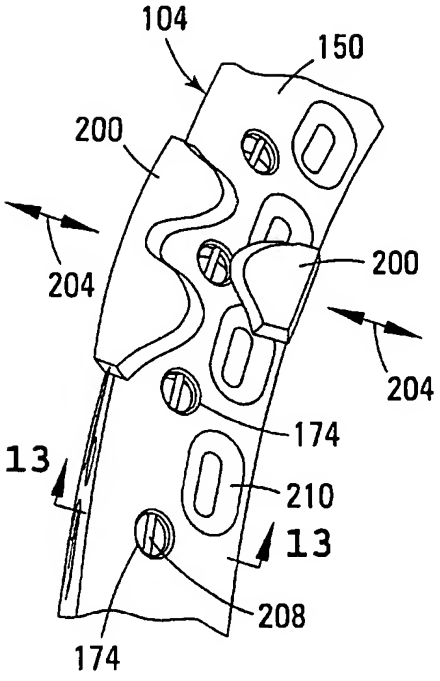

FIG. 10

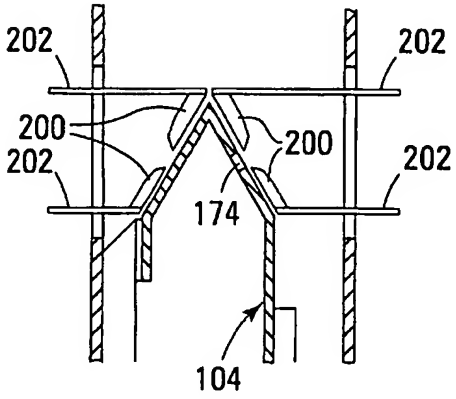

FIG. 11

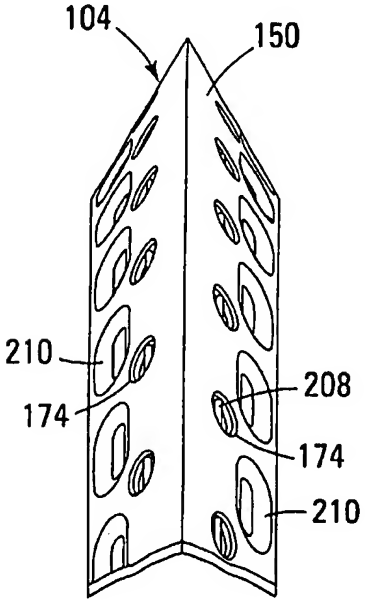

FIG. 12

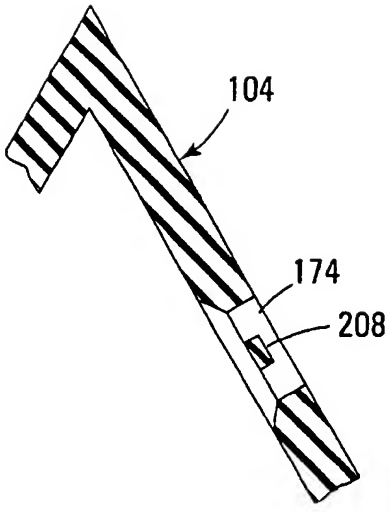

FIG. 13

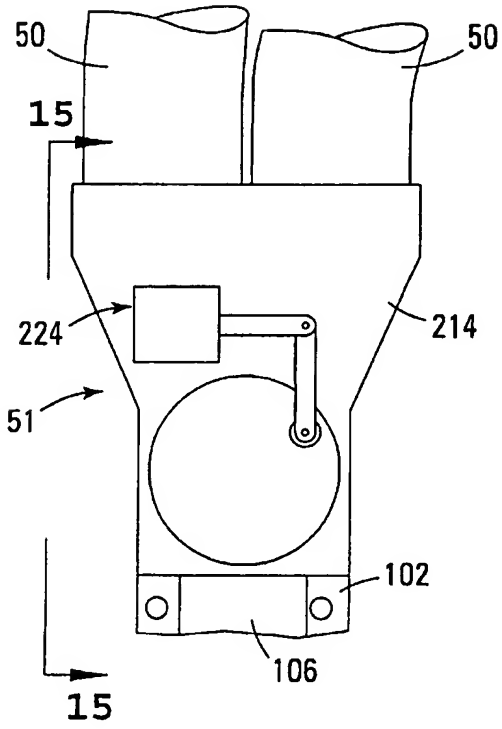

FIG. 14

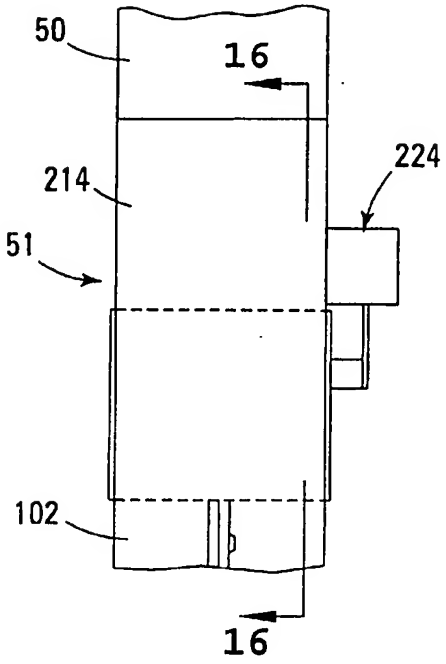

FIG. 15

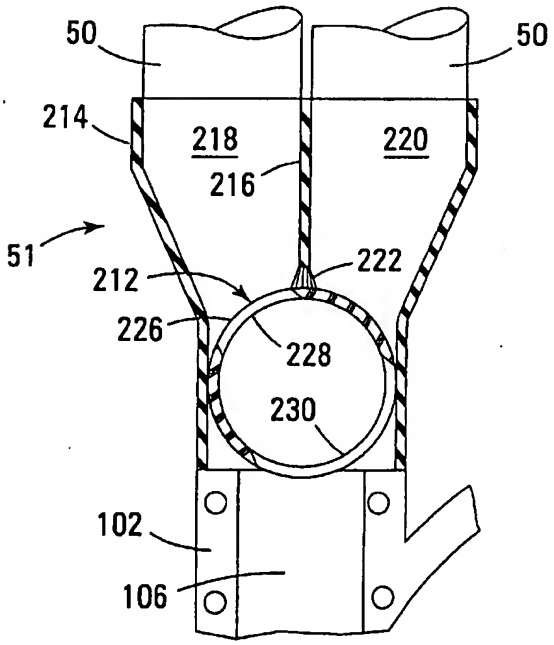

FIG. 16

VACUUM SEED METER AND DISPENSING APPARATUS

BACKGROUND OF INVENTION

1. Field of the Invention

The present invention relates generally to mechanisms used in agricultural planting machines for selecting and dispensing individual seeds and more particularly to such mechanisms which employ a vacuum pressure to singulate and dispense the seeds.

2. Description of the Related Art

It is well recognized that uniformity of seed spacing in the seed furrow is essential for achieving a field's maximum crop yield potential and thus the profitability of the farmer's operation. Modern agricultural planters use various types of seed metering devices which, ideally, are designed to select and dispense individual seeds at regular intervals. Unfortunately, however, most of these commercially available seed metering devices often fail to perform as ideally designed in that the seed meter will occasionally miss or skip a seed thereby resulting in gaps in the seed spacing, or, alternatively, the seed meter will dispense two or more seeds at a time (i.e., doubles or triples) instead of dispensing individual seeds.

The cause of most skips or doubles can be attributed to factors such as lack of proper maintenance of the seed meter or the failure on the part of the farmer to change out components of the seed meter when switching between planting seeds of different shapes or sizes. Despite the knowledge that failure to perform proper maintenance or failure to change out components of the meter when switching to planting seeds of different sizes and shapes may result in lower yields, many farmers elect not to engage in these time-consuming practices during the rush of the planting season. Accordingly, there is a need in the agricultural industry for a seed metering device that requires little maintenance and one that can plant a wide range of different sizes and shapes of seeds and which is further capable of planting a wide range of seed populations without having to change out components, thereby minimizing down-time, while still maintaining desired uniformity and accuracy in selecting and dispensing individual seeds.

As identified above, there are various types of seed metering devices currently being used on modern conventional agricultural seed planters. These various types of seed meters are substantially divided into two categories on the basis of the seed selection mechanism employed, namely, mechanical or pneumatic. The commercially available mechanical meters include finger-pickup meters such as disclosed in U.S. Pat. No. 3,552,601, cavity-disk meters such as disclosed in U.S. Pat. No. 4,613,056, and belt meters such as disclosed in U.S. Pat. No. 5,992,338. Commercially available pneumatic meters include vacuum-type meters such as disclosed in U.S. Pat. No. 5,501,366, and compressed air meters. There are also commercially available meters that combine the seed selection mechanisms of both mechanical and pneumatic meters such as disclosed in U.S. Pat. No. 4,074,830. Of the various types of seed meters, vacuum-type meters offer certain advantages and desirable features over the other types of meters.

In general, most vacuum-type meters, such as those disclosed in U.S. Pat. Nos. 4,241,849; 4,285,444; 4,688,698; 4,793,511; 5,170,909; 5,392,707; 5,501,366; 5,542,364; 5,740,747; and 6,109,193, utilize a rotary disk or plate having one or more concentric circular rows of equally spaced apertures. A vacuum is applied to one side of the disk thereby creating a negative pressure differential on opposite sides of the disk. In use, the disk rotates through a seed reservoir located on the opposite side of the disk to which the vacuum is applied. The negative pressure differential causes seeds to be held or entrained over the apertures as the apertures rotate through the seed reservoir. Excess seeds are then removed by a seed stripper and the individual seeds that remain entrained over the apertures are then dispensed one at a time at a discharge point located on the path of travel of the apertures before the apertures re-enter the seed reservoir.

Another vacuum-type meter as disclosed in U.S. Pat. No. 6,142,086 discloses the utilization of a rotatable vacuum drum as opposed to a rotatable vacuum disk or plate as part of the seed selection mechanism. The vacuum drum of the '086 patent includes a row of circumferentially spaced apertures about the outer circumferential periphery of the drum and further includes a seed tube for "plucking the seeds" off rotatable drum. The use of a seed tube to "pluck" the seeds from the rotating drum may potentially damage the seeds which may effect the ability of the seed to germinate.

Those skilled in the art recognize that most of the commercially available type meters typically require less maintenance than other types of meters since vacuum-type meters usually have fewer moving parts that tend to wear with use, particularly as compared to the finger-pickup type meters. Additionally, with vacuum-type meters, usually a single vacuum disk or drum can be used for planting a wider range of seed shapes and sizes without the need for changing out components and without sacrificing the performance of the seed meter. Finger-pickup meters, on the other hand, usually require the farmer to change out the backing plates or the seed stripper inserts when switching among seeds having a different sizes or shapes in order to maintain the same degree of performance. Similarly, with belt-type meters or seed cavity disk meters, it is likewise usually necessary to change the belts or the cavity disks, respectively, to accommodate different seed sizes and shapes.

Thus, while vacuum-type meters offer certain desired advantages over mechanical meters, most commercially available vacuum-disk meters suffer from certain other disadvantages relating to their manufacture. One particular problem relates to maintenance of the vacuum or pressure differential, particularly with respect to vacuum-type meters that utilize a vacuum disk as opposed to a vacuum drum. In vacuum-disk meters, the sealing arrangement between the disk and the housing must be sufficiently effective to minimize localized variations in the vacuum around the circumference of the disk. To minimize any irregularities between the seal of the disk and the housing, the disk is typically manufactured from a rather heavy stainless steel plate that must be precisely rolled and machined under very fine tolerances. Thus, vacuum-disks are typically expensive and difficult to manufacture. Accordingly, there is a need in the industry to provide a metering device which offers the features and advantages of a vacuum-type meter, but which is more easily manufactured and does not require the expensive machining operations and fine tolerances. Additionally, there is a need in the industry for a vacuum-type meter which will gently release the seeds such that the seeds are not damaged when discharged.

Furthermore, recent technological advances in global positioning systems (GPS) and availability of satellite imagery and yield monitors on harvesting equipment have enabled farmers to map their fields based on a number of conditions. Farmers are now able to match seed varieties to the various soil conditions that may be encountered in any

given field. For example, a particular variety of seed may produce higher yields in sandy soil than in clay or loess soils which may be encountered based on the topography of the field. Additionally, certain varieties of seeds may have more disease resistance or will better tolerate field conditions where there may occasionally be standing water due to poor drainage. Therefore, there is a need in the industry for a planting system which allows the planter to switch between different varieties of seeds while on-the-go as the planter encounters different soil conditions in the field or where certain areas of the field require different disease resistance.

Finally, in most modern conventional agricultural planters, the seed meters (whether finger-pickup type, vacuum-disk type, cavity-disk type or belt-type) are typically mounted just below the seed hopper of the planter such that a constant supply of seeds from the seed hopper may gravity feed into the seed reservoir of the seed meter housing. Thus, the seed meters on most conventional modern planters are located eighteen to twenty-four inches above the ground surface and, as a result, require a seed tube to direct the seeds into the seed furrow after the singulated seeds are discharged from the seed meter. It should be appreciated, therefore, that as the planter traverses the field, some of the seeds may quickly free-fall through the eighteen to twenty-four inch long seed tube while other seeds may hit the sides of the tube and bounce within the tube before landing in the bottom of the furrow. The difference in time between those seeds which quickly fall through the tube versus those seeds that hit and bounce within the tube results in unwanted irregularities in the seed spacing.

Therefore, in some applications it may be desirable to eliminate the need for a seed tube altogether by mounting the seed metering device near the soil surface such that the singulated seeds are discharged from the seed metering device just a few inches above the bottom of the furrow. By mounting the seed meter near the bottom of the seed furrow, the seeds will be more accurately dispensed in the furrow and the irregularities in seed spacing caused by the seeds falling through the seed tube at different speeds will be significantly reduced if not completely eliminated. In this regard, it would be desirable to mount a seed meter such that it is disposed between the furrow opening assembly and the furrow closing wheel assembly of a conventional planter. Unfortunately, most commercially available vacuum-disk meters are too large in diameter or two wide to be disposed in the confined space between the furrow opening assembly and the closing wheels of a conventional planter.

Based on the foregoing, there is a need in the agricultural industry for a seed meter that provides accurate, consistent and uniform seed placement for various types of crops and can plant a wide range of seed populations without the need for changing out components. In addition, there is also a need in the industry for a seed metering and dispensing device that is readily adapted for retrofitting most conventional planters which will eliminate the need for seed tubes by being adapted for mounting between the furrow opening assembly and the furrow closing wheel assembly and near the soil surface such that the seeds are gently deposited directly in the seed furrow thereby improving seed placement accuracy.

SUMMARY OF INVENTION

A seed meter having a stationary housing defining a seed supply reservoir, a seed singulation area and a seed discharge area. The seed supply reservoir is in communication with a supply of seeds disposed within the seed hopper of the planter. The seed meter includes a rotatable drum disposed within the stationary housing. The rotatable drum has an interior vacuum chamber in communication with a vacuum source disposed on the planter. The rotatable drum further has an annular circumferential periphery with a plurality of equally spaced apertures therein and wherein at least a portion of the annular circumferential periphery rotates through the seed supply reservoir. The annular circumferential periphery of the drum is preferably V-shaped when viewed in cross section, but the circumferential periphery may also be beveled to one side or substantially horizontal in cross-section.

In operation, the suction force created by the vacuum source draws air through the apertures into the vacuum chamber thereby causing the seeds in the seed supply reservoir to be entrained over the apertures as the apertures rotate through the seed supply reservoir. A seed release is preferably disposed inside the rotatable drum in the seed discharge area. The seed release preferably has a portion biased against an inside surface of the annular circumferential periphery of the drum such that at least the portion of the seed release substantially covers at least one aperture at a time as the drum rotates such that the suction force through the apertures is substantially cut-off thereby gently releasing the seeds entrained over the apertures. In the preferred embodiment, a seed release disposed on the interior of the drum is used in combination with an exterior drum wiper secured to the housing in the seed discharge area of the meter to ensure that all seeds are removed from the apertures before the apertures re-enter the seed reservoir. In an alternative embodiment, the seed release may also utilize positive air pressure to discharge the entrained seed from the rotating drum. In yet a further embodiment, rather than using a seed release disposed on the interior of the drum, an exterior drum wiper, alone, may be used to remove the seeds from the apertures before the apertures re-enter the seed reservoir.

In a preferred embodiment, the seed meter is in communication with a seed hopper containing separate compartments for holding different varieties of seeds. In this preferred embodiment, the seed meter includes a diverter which can be manually or automatically triggered to switch between the different seed varieties while on-the-go.

The seed meter may be disposed below the seed hopper, as is conventional in most planters. However, the seed meter is preferably disposed near the soil surface, rearwardly adjacent the furrow opening assembly and forward of the furrow closing assembly of a conventional planter such that the seeds are discharged directly into the seed furrow thereby eliminating the need for a seed tube which effects the uniformity of seed placement in the furrow.

To the accomplishment of the above objects, features and advantages, this invention may be embodied in the forms illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and the changes may be made in the specific form illustrated and described within the scope of the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 shows a conventional agricultural planter illustrating the use of a conventional seed meter and seed dispensing tube.

FIG. 2 shows the conventional agricultural planter of FIG. 1 with the seed meter and seed dispensing tube replaced with the preferred embodiment of the seed metering and dispensing device of the present invention.

FIG. 3 shows a side elevation view of the preferred embodiment of the seed metering and dispensing device of the present invention.

FIG. 4 shows a cross-sectional side elevation view of the preferred embodiment of the seed metering and dispensing device of the present invention as viewed along lines 4—4 of FIG. 3.

FIG. 5 shows a cross-sectional top plan view of the preferred embodiment of the seed metering and dispensing device of the present invention as viewed along lines 5—5 of FIG. 3.

FIG. 6 shows a cross-sectional view of the boot as viewed along lines 6—6 of FIG. 2.

FIG. 7 shows a detailed view of the housing wall members illustrating the preferred embodiment for removably attaching the inner and outer wall members of the housing.

FIG. 8A shows a detailed cross-sectional view of the preferred embodiment of the circumferential outer periphery of the rotatable drum.

FIG. 8B shows a detailed cross-sectional view of an alternative embodiment of the circumferential outer periphery of the rotatable drum.

FIG. 8C shows a detailed cross-sectional view of another alternative embodiment of the circumferential outer periphery of the rotatable drum.

FIG. 9A shows a detailed view of an alternative embodiment of the seed release.

FIG. 9B shows a detailed view of another alternative embodiment of the seed release.

FIG. 10 shows the preferred embodiment of a seed stripper disposed on the preferred embodiment of the annular circumferential periphery of the drum.

FIG. 11 shows a cross-sectional view of the drum and preferred seed stripper as viewed along lines 11—11 of FIG. 3 disposed on the preferred embodiment of the circumferential outer periphery of the drum.

FIG. 12 shows a detailed view of a portion of the preferred annular circumferential periphery of the drum.

FIG. 13 shows a cross-sectional view of the preferred aperture detail as viewed along lines 13—13 of FIG. 10.

FIG. 14 shows a detailed side elevation view of the preferred diverter shown in FIG. 2.

FIG. 15 shows a rear elevation view of the preferred diverter as viewed along lines 15—15 of FIG. 14.

FIG. 16 shows a detailed cross-sectional view of the preferred diverter as viewed along lines 16—16 of FIG. 15.

DETAILED DESCRIPTION

Drawing FIG. 1 shows a modern agricultural planter **10**, such as that disclosed in U.S. Pat. No. 4,009,668, the specification and drawings of which are incorporated herein by reference. As is conventional, the planter **10** includes a mobile main frame **12**, only a portion of which is illustrated in FIG. 1. As is well known, the main frame **12** is conventionally attached to and towed by a tractor (not shown) and a number of individual row units **14** are spaced at intervals along the main frame **12**. Each row unit **14** includes a row unit frame **16**, which is vertically adjustable relative to the main frame **12** by a parallel linkage **18**. Only one single row unit **14** is shown and described herein, and, as is conventional, each row unit **14** includes a seed hopper **20** and a fertilizer hopper **22** mounted on the row unit frame **16**. Each row unit **14** has a seed selection and dispensing device **100**, commonly referred to as a seed meter, which receives seed from the seed hopper **20** and discharges the seed **25** into a seed tube **26** at regular intervals.

A coulter **28** is typically mounted on the row unit frame **14** forwardly of the furrow opening assembly **30**. The furrow opening assembly **30**, typically comprises a pair of generally vertical disks **32** that rotate on generally horizontal transverse shafts **34** supported by downwardly extending brackets **36** from a row unit subframe **38**. The axes of the respective furrow opening disks **32** are slightly inclined relative to one another so that the disks **32** contact one another forwardly and bellow the disk axes. In operation, the lower portion of the furrow opening disks **32** are disposed below the surface of the soil so that the disks form a V-shaped furrow **40** as the planter **10** advances. The see tube **26**deposits the seed in the furrow **40** behind the axis of the furrow opening disks **32**. A gauge wheel assembly **42** is mounted on the row unit subframe frame **38** adjacent the furrow opening disks **32**. The gauge wheel assembly **42** comprises a pair of gauge wheels **44** disposed adjacent the outer sides of the furrow opening disks **32**. A gauge wheel arm **46** connects each gauge wheel **44** to the row unit subframe **38**. As is well known, an adjustable stop (not shown) operates between the row unit subframe **38** and the gauge wheel arm **46** to limit the upward movement of the gauge wheel **44** relative to the row unit subframe **38**. Since the gauge wheels **44** ride on the surface of the ground when the planter **10** is in operation, the vertical position of the gauge wheels **44** relative to the furrow opening disks **32** controls the depth of the furrow **40** opened by the disks **32**. A furrow closing assembly **48** disposed rearwardly of the furrow opening assembly **30**, closes the furrow **40** by pushing the soil back into the furrow over the planted seeds. All the above is described in greater detail in U.S. Pat. No. 4,009,668.

In regard to the furrow opening assembly **30**, wherein the assembly **30** was described as typically comprising a pair of generally vertical disks **32**, it should be appreciated that some conventional planters utilize a furrow opening assembly **30** having only one furrow opening disk **32**, while still other furrow opening assemblies utilize a shovel or the like. Thus, it should be understood that reference to the furrow opening assembly **30** throughout this specification is intended to include any type of furrow opening assembly, whether comprised of a pair of disks, a single disk, a shovel, or any combination thereof, or any other means which is or may be employed to create a furrow in the soil. Similarly, reference to the furrow closing assembly **48** throughout this specification is intended to include any apparatus which is or may be employed for replacing the soil over the planted seed in the furrowDrawing FIG. **2** is intended to represent the same planter as in FIG. **1** except that the seed dispensing tube **26** is removed and the seed meter **100** is disposed near the soil surface and rearward of the furrow opening assembly **30** and forward of the furrow closing assembly **48** such that the seeds are discharged from the meter **100** directly into the bottom of the furrow **40**, thereby ensuring seed placement accuracy by eliminating the spacing irregularities caused by the seeds being discharged into a seed tube.

FIG. **2** also illustrates a preferred embodiment of a planter **10** in which the seed hopper **20** is divided into at least two separate compartments **20A**, **20B** for holding different varieties of seeds. Feed tubes **50** communicate the seed **25** by gravity flow from each of the compartments **20A**, **20B** to the seed meter **100**. As will be explained in greater detail later, a diverter **57** controls the flow of seeds from the compartments **20A**, **20B** into the seed supply reservoir of the seed meter **100**. Additionally, a vacuum tube **52**, as shown in

FIGS. 1 and 2, is attached at one end to a suitable conventional vacuum source (not shown) and the other end is attached to the meter **100** to provide negative pressure to the interior of the vacuum drum of the seed meter as described in greater detail later. Although not shown, the planter **10** of FIG. **1** may also include a diverter **57** and divided seed hopper **20**to allow for planting two or more varieties of seeds as described in detail later.

Continuing to refer to FIG. **2**, the seed meter **100** includes a housing **102** having a bracket **103** secured thereto or preferably formed integral therewith. The bracket **103** may be removably mounted to the row unit frame **16** as in FIG. **1**, or preferably to the row unit subframe **38** as shown in FIG. **2**, such as by a bolted connection. On certain planters, such as most Deere and Kinze planters, when mounting the meter **100** to the row unit subframe **38** as shown in FIG. **2**, the bracket **103** may be attached to the existing disk scraper mounting holes in the row unit subframe **38**. In drawing FIG. **2**, one of the furrow opening disks **32** and one of gauge wheels **40** have been removed for clarity to show the preferred positional relationship of the mounting of the meter **100** between the furrow opening assembly **30** and the furrow closing assembly **48**. Additionally, as shown in FIG. **2**, a conventional, commercially available boot **105** is preferably mounted to the downwardly extending bracket **36** of the row unit subframe **38** to protect the meter **100** from dirt and debris during planting operations. As best viewed in FIG. **6**, a cross-sectional view of the boot **105** is illustrated showing the location of the boot **105** with respect to the rotatable drum **104** of the seed meter **100** and the furrow **40**. The boot **105** may be made of any suitable wear resistant material such as a molded polymer material. On most Deere planters, the boot **105** may be attached directly to the bracket **36** using the existing seed tube guard mounting holes in the bracket **36**.

FIG. **3** illustrates a more detailed side elevation view of the seed metering and dispensing device **100** of FIGS. **1** and **2**. FIGS. **4** and **5** are cross-sectional views of the meter **100** as viewed along lines **4—4** and **5—5** of FIG. **3** respectively. Accordingly, referring to FIGS. **3–5**, the metering and dispensing device **100** includes a housing **102** which substantially surrounds a rotatable vacuum drum **104**. The housing **102** defines one seed supply reservoir **106** (FIGS. **3** and **5**), a seed singulation area **108** (FIG. **3**) and a seed discharge area **170** (FIGS. **3** and **4**). Additionally, the housing **102** preferably includes a vacuum inlet portion **112** which receives one end of a vacuum tube **52** connected to any conventional vacuum source (not shown).

The housing **102** is preferably made of a wear resistant, rigid polymer material, but it may also be made out of other suitably wear resistant rigid material such as aluminum or steel. Preferably at least one wall **114** of the housing **102** is removable from the other wall **116** of the housing to gain access to the rotatable vacuum drum **104** disposed therein for cleaning and maintenance. Preferably, the walls **114, 116** of the housing **102** include lip portions **118** which can be removably secured together by fasteners, such as screws, clips or the like. In the preferred embodiment, the lip portion **118** of the removable wall **114** includes a plurality of apertures **120** (best viewed in FIG. **1**) which receive deformable male studs **122** fixed to the lip portion **118** of the other wall member **114** of the housing **102**.

As best viewed in FIGS. **4** and **5**, a sprocket **123** is preferably secured to one end of a shaft **124**. Preferably, a continuous chain (not shown) engages the sprocket **123** and a drive shaft (not shown) which allows the shaft **124** to rotate at various selected speeds independent of the ground speed of the planter. By allowing the shaft **124** to rotate at various speeds independent of the ground speed of the planter, the drum **104**, which is preferably secured to the shaft **124** as described below, is able to rotate at various speeds in order to allow the operator to vary the seed population being planted. Naturally, various other drive mechanisms recognized by those skilled in the art may be used to rotate the shaft **124** and drum **104**, and therefore the present invention should not be considered as limited to the use of a chain drive mechanism only.

The other end of the shaft **124** extends through the wall **116** of the housing **102** and is rotatably received by a bearing hub assembly **126** rigidly fixed to the housing wall **116**. In an alternative embodiment, the bearing hub assembly **126** may be formed integral with the wall **116**of the housing **102**. In a preferred embodiment, the bearing hub assembly **126** is comprised of an end plate **128** having a central bore to receive an annular flanged bearing member **130**. Received within an inner portion of the annular flanged bearing member **130** is an outer raceway **132** for a first set of ball bearings **134**. The outer raceway **132** is preferably removably fixed within the inner portion of the annular flanged bearing member **130**. Also received within the inner portion of the annular flanged bearing member **130** is an inner raceway **136** for the first set of bearings **134**. The inner raceway **136** is preferably removably fixed to the shaft **124**, such as by a set screw, key or other conventional means of attachment. Disposed within the outer portion of the flanged bearing member **130** is a second set of inner and outer raceways **138, 140** and bearings **142**. Again, the outer raceway **138** is preferably removably fixed within the outer portion of the annular flanged bearing member **130** and the inner raceway **140** is preferably removably fixed to the shaft **124** by any conventional means. It should be appreciated, therefore, that due to the bearing hub assembly **126**, the shaft **124** and inner raceways **134, 140** removably fixed thereto, are free to rotate as a unit about their central axis **142** with respect to the stationary housing **102** and end plate **128**.

Continuing to refer to FIGS. **4** and **5**, the rotatable vacuum drum **104** is preferably fabricated from a wear resistant, blow-molded polymer material, but the drum **104** may also be fabricated from any other suitable wear resistant material including steel, aluminum, etc. The vacuum drum includes an annular circumferential outer periphery **150**, outer wall portion **152** and an inner wall portion **154**. The outer wall portion **152** includes a central bore **156** for receiving the end of the shaft **124**. Inner and outer wall reinforcing plates **156, 158** also having a central bore **160, 162** for receiving the shaft **124** are preferably secured to the outer wall portion **152** to add structural rigidity to the vacuum drum **104**. It should be appreciated, however, that if the outer wall portion **152** is sufficiently rigid, the inner and outer wall reinforcing plates **156, 158** may not be required.

The inner wall portion **154**, is adjacently spaced in close proximity to the stationary end plate **128** and the inner wall portion **154** preferably includes a large central opening **164**. An annular seal **166**, preferably comprised of wear resistant, low friction material such as Teflon or the like, is disposed between the stationary end plate **128** and the inner wall portion **154** of the drum **104**. A nut **168** disposed on the end of the shaft **124** removably fixes the drum **104** to the rotatable shaft **124** by an abutting connection between the face of the inner wall reinforcing plate **156** and the outer face of the inner raceway **140**. The nut **168** also maintains the closely spaced adjacent relation between the inner wall portion **154** of the drum **104** and the stationary end plate **128** of the housing **102** such that a substantially air-tight seal is

maintained between the inner wall portion **154** and the end plate **128**. A bore **110** is located within the stationary end plate **128** over the location of the vacuum inlet **112** of the housing **102**. Thus, it should be appreciated that a vacuum chamber **112** is created within the interior of the rotatable drum **104** and the seal **166** prevents air from entering between the inner wall portion **154** of the drum **104** and the housing **102**.

Naturally, various embodiments of the drum **104** and bearing hub assembly **126** are possible without materially departing from the teachings herein. For example, as disclosed in U.S. Pat. Nos. 3,990,606 and 6,142,086, rather than having one end of the drum substantially open and sealed against a stationary end plate **128** of the housing **102**, the drum **104** may be a substantially closed cylindrical drum with only a small central bore therethrough for receiving a tubular shaft which terminates in the interior vacuum chamber of the drum; the other end of the shaft being in direct communication with the vacuum source. Thus, the detailed description of the preferred embodiment of the drum **104** and bearing hub assembly **126** described herein should not be considered as limiting the scope of the present invention.

The annular circumferential periphery **150** of the rotatable drum **104** includes at least one row of equally spaced apertures **114**. In operation, at least a portion of the annular circumferential periphery **150** of the drum **104** rotates through the seed reservoir **106** (FIGS. **2, 5**). The seeds **25** in the seed reservoir **106** are entrained over the apertures **114** due to the suction force created by the negative pressure differential between the interior of the drum **104** and the atmospheric pressure on the exterior of the drum **104**.

It is contemplated that the annular circumferential periphery **150** of the drum **104** may take any number of configurations such as those shown in FIGS. **8A–8C**, for example. In the preferred embodiment, the annular circumferential periphery **150** of the drum **104** is substantially V-shaped when viewed in cross-section as shown in FIG. **8A**. However, alternative embodiments may also be used. For example, the annular circumferential periphery **150** may be beveled to one side as shown in FIG. **8B**, or, alternatively, the annular circumferential periphery **150** may be substantially horizontal when viewed in cross-section as illustrated in FIG. **8C**. As best viewed in FIG. **12**, the annular periphery **150** preferably has two rows of equally spaced apertures **114** with each row of apertures being offset from the other row of apertures by one-half the opposing aperture row spacing. By providing two offset rows of apertures **114**, a smaller diameter drum **104** may be utilized then would otherwise be required if the drum had only a single row of apertures or if the seed meter utilized a disk as opposed to a drum. In the preferred embodiment the diameter of the drum is approximately eight to nine inches in diameter with thirty-eight apertures **114** in each row. Naturally, however, the diameter of the drum and the number of apertures may vary depending on seed population requirements, the speed of rotation of the drum, the space requirements within the drum for providing a seed release (discussed below) and the space available for mounting the meter **100** to the planter **10** either below the seed hopper **20** as shown in FIG. **1** or between the furrow opening assembly **30** and furrow closing assembly **48** as shown in FIG. **2**.

A substantially V-shaped configuration of the annular circumferential periphery **150** of the drum **104** is preferred for a number of reasons. First, a V-shaped configuration allows for a greater number of sufficiently spaced apertures **174** in a smaller diameter drum to enable a single drum to plant a wider range of seed sizes and a wider range of seed populations. For example, when planting smaller round seeds, such as soybeans for example, the apertures **114** may be more closely spaced without the concern for a single seed bridging adjacently spaced holes. However, when planting larger flat seeds, such as corn for example, bridging is more of a concern. If bridging occurs due to the apertures being spaced too closely, a single seed will cover two apertures thereby resulting in unwanted gaps in seed spacing. Therefore, since it is desired to provide a seed meter that is capable of planting a wide range of various sizes and shapes of seeds and to also provide a seed meter capable of planting a wide range of seed populations without having to change-out components of the meter, the V-shape configuration allows for more apertures **174** in the same diameter as compared to a seed meter utilizing a flat vacuum disk plate, or even compared the alternative embodiments of the drum shown in FIG. **8B** or **8C**.

Second, since it is preferable to eliminate the need of a seed tube by mounting the meter **100** on a conventional planter near the soil surface between the furrow opening assembly **30** and the furrow closing assembly **48** such that the meter **100** dispenses the seeds directly into the seed furrow **40**, the V-shaped configuration is preferred because the two offset rows of apertures **174** may be spaced more closely without the concern of bridging, thereby allowing the seeds dispensed from both rows of apertures to fall more closely along the centerline of the furrow. If the annular circumferential periphery **150** of the drum **104** is beveled or substantially horizontal as shown in FIGS. **8B** and **8C**, respectively, the seeds dispensed from the two rows of apertures will be offset a greater distance from the centerline of the furrow **40**. On the other hand, if the meter **100** is mounted below the seed hopper **20** as shown in FIG. **1** such that the seeds are deposited into a seed tube **26**, as is conventional, the closeness of the adjacently spaced aperture rows is not as big of a concern and therefore the alternative embodiments of FIG. **8B** and **8C** are more than appropriate.

Third, the V-shaped annular circumferential periphery is preferred because the smaller the diameter of the drum **104** and the closer the adjacently spaced aperture rows can be, the smaller and narrower may be the profile of the drum **104** and housing **102**, which is particularly important when mounting the meter **100** in the confined space between the furrow opening assembly **30** and furrow closing assembly **48** as shown in FIG. **2**. It should be appreciated that reference to the annular circumferential periphery **150** as being preferably substantially V-shaped in cross-section is intended to include similar configurations that accomplish the above identified features and advantages of the V-shaped configuration, such as substantially U-shaped configurations, and the like.

Referring to FIGS. **3** and **4**, disposed within the interior of the drum **104** at the seed discharge area **10** is a seed release **180** preferably comprising a rotatable wheel **182** biased against the interior surface of the annular circumferential periphery **150** of the drum **104**. In operation, as the apertures **174** in drum **104** rotate past the stationary rotating wheel **182**, the apertures are sealed off one at a time by a portion of the wheel **182** thus cutting off the effects of the vacuum source and thereby releasing the seeds entrained over the apertures **174** one at a time. The entrained seeds are therefore gently released such that the seeds fall into the seed tube as shown in FIG. **1**, or directly into the seed furrow as shown in FIG. **2**.

As best illustrated in FIG. **3**, an arm **184** is pivotally connected to a shaft **186** fixed to the housing **102**. A tension spring **188** is disposed around the shaft **186** with one end

removably fixed to the pivotal arm **184** and the other end biased against a plurality of stops **190** projecting outwardly from the stationary end plate **128** toward the tension spring **188**. The end of the tension spring **188** is preferably adjustable between the stops **190** to vary the amount of tension on the spring **188** to either increase or decrease the amount of radial force exerted on the wheel **182**.

Furthermore, the location of the seed release **180** is preferably adjustable within the interior of the drum **104** between approximately the four-o'clock to seven-o'clock position depending on the speed at which the drum **104** rotates for variations in desired seed population such that the seed, when released, falls vertically as it is released from the rotating drum **104**. In addition to a seed release **180**, a wiper **192** is also preferably disposed within the housing **102** to ensure the entrained seeds are removed from the apertures **174** before the apertures re-enter the seed reservoir **106**.

In an alternative embodiment, rather than utilizing a wheel **182**, the seed release may be comprised of a shoe **194** biased against the interior surface of the annular circumferential periphery as shown in FIG. **9**A. Additionally, the shoe **194** may have an open cavity **196** connected to a positive air source, such as by a tube or hose **198** as shown in FIG. **9**B, which maintains a positive pressure within the open cavity **196** to improve the release of the seed from the effects of the vacuum source and to force out any entrained seeds that might otherwise become partially stuck in the aperture **174**.

FIG. **10** shows a preferred embodiment of the seed stripers **200** used to remove any multiple seeds that may be entrained over a single aperture **174** thereby leaving a single seed entrained over each aperture **174**. The seed strippers **200** are preferably supported within the housing **102** by adjustable brackets **202** which allow the strippers **200** to move with respect to one another in the direction indicated by the arrows **204** depending on the various size and shaped seeds being planted. FIG. **11** shows a cross-sectional view of the drum **104** and seed strippers **200** as viewed along lines **11**—**11** of FIG. **3** illustrating the preferred arrangement of the seed strippers **200** on the annular circumferential periphery **150** of the rotating drum **104**. Additionally, as shown in FIGS. **3** and **4**, a brush **206** is disposed between the housing **102** and the drum **104** such that any seeds stripped from the apertures **174** by the seed strippers **200** are directed back into the seed supply reservoir **106**. Although only one preferred embodiment of the seed stripper has been shown, it should be readily appreciated that the seed strippers **200** may also be any other type or configuration common in other seed metering devices, whether a saw tooth configuration, rollers, or the like.

Referring now to FIGS. **12** and **13**, to minimize seed doubles and to provide the ability to plant a broader range of seed types with the same size aperture in the drum **104**, the apertures **174** preferably include a thin web or spline **208**, thus splitting the aperture **174** substantially into two halves. The web **208** prevents narrow or elongated seeds from entering the apertures **174** where they might otherwise become stuck in the aperture or possibly get sucked into the interior vacuum chamber **112**, yet the area of the aperture opening is still sufficient to entrain larger seeds such as corn or soybeans. FIG. **13** shows a cross sectional view of the aperture **174** as viewed along lines **13**—**13** of FIG. **10**. As shown in FIG. **13**, at each aperture **174**, the inside of the annular circumferential periphery **150** of the drum **104** is preferably beveled which slightly increases the amount of suction force to entrain the seeds than would otherwise be achieved if the inside surface of the aperture was not beveled. The diameter of each aperture is preferably approximately 5 mm.

Referring now to FIGS. **10** and **12**, the annular circumferential periphery **150** of the drum **104** preferably includes dimples **210** for agitating the seed in the seed supply reservoir **106** as the drum rotates in order to prevent the seeds from becoming packed within the reservoir **106**, thereby enabling the seeds to be more readily entrained on the rotating drum **104**. Rather than dimples **201** , the drum **104** may instead have pegs which project outwardly to agitate the seeds in the reservoir **106**. Alternatively, any other conventional means for agitation of the seed reservoir may be used, such as compressed air, vibration, etc.

FIG. **14** shows a detailed side-elevation view of the preferred diverter **51** shown generally in FIG. **2**. FIG. **15** shows a rear elevation view of the preferred diverter **51**. FIG. **16** shows an enlarged cross-sectional view of the preferred diverter **51** as viewed along lines **16**—**16** of FIG. **15**. The preferred diverter **51** is preferably comprised of a valve **212** rotatably disposed in an adapter **214** which mounts to the inlet of the seed reservoir **106** of the housing **102**. The adapter **214** preferably includes a separating wall **216** which divides the adapter into at least two compartments **218**, **220**, each compartment being in communication with a feed tube **50** which is in-turn in communication with one of the compartments **20**A, **20**B of the seed hopper **20** as discussed above. A brush **222** preferably extends between the separating wall **216** and the valve **212** to prevent the different seed varieties in each compartment **218**, **220** from mixing. Referring to FIG. **14**, an actuator **224**, such as a solenoid, is mounted to the exterior of the adapter **212** and is pivotally linked to the valve **212** for moving the valve to selectively open and close the compartments **218**, **220**. In the preferred embodiment, the valve **212** is preferably comprised of a cylinder **226** rotatably secured in the adapter **214**. The cylinder **226** includes two openings **228**, **230** on opposing sides of the cylinder **226**. During the planting operations, when it is desired to switch between seed varieties, the planter operator can preferably actuate the actuator **224** by flipping a switch in the cab of the tractor which is electrically connected to the actuator **224**. Actuation of the actuator **224** causes the cylinder **226** to rotate which opens one of the compartments **218**, **220** and closes the other compartment **218**, **220** such that the seeds in the open compartment can enter the seed reservoir **106** of the housing. When it is desired to switch back to the previous variety of seed, the valve **212** rotates the opposite direction thereby closing off the previously opened compartment and opening the previously closed off compartment. Various alternate embodiments of the diverter **51** may be used to accomplish the objective of allowing different varieties of seeds to be planted while on-the-go, therefore the scope of the invention should not be considered as limited to the preferred embodiment described herein.

When using a diverter **51**, it should be appreciated that the volume of the seed reservoir **106** must not be too large such that a large quantity of a particular variety of seeds are retained. Otherwise, by the time first variety of seeds in the seed reservoir **106** are used up, the planter may have already passed the location in which it was desired to plant the second variety of seeds. Thus, it is preferred that the seed reservoir **106** retain no more seeds than will be dispensed within fifty to seventy-five feet. Naturally the volume of the seed reservoir and the quantity of seeds retained therein may vary as desired and therefore, the above-described preferred volume should not be considered as a limitation to the scope of the invention.

Furthermore, it should be readily appreciated that rather than providing a diverter **51** for planting only two seed

varieties, it may be desirable to have the ability to switching between planting three or more seed varieties. This may be accomplished by providing multiple diverters **51** or providing a single diverter with an adapter **214** having multiple compartments and a valve **212** having multiple positions for opening and closing the various compartments, such as by a rotatable disk with an opening movable between the multiple compartments. Furthermore, rather than the planter operator manually controlling the diverter **51** by flipping a switch in the tractor cab, it would be desirable to electrically couple the diverter actuator to the farmer's GPS system and field mapping system such that the diverter is automatically actuated as the planter traverses the field. Those skilled in the art would readily appreciate how to electronically couple the diverter **51** to a field mapping and GPS system and therefore further discussion is not warranted.

Although only certain exemplary embodiments of the invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims.

What is claimed is:

1. A seed meter for selecting and dispensing individual seeds at regular intervals, said seed meter comprising:

a housing defining a seed supply reservoir, a seed singulation area and a seed discharge area;

a rotatable drum disposed within said housing, said rotatable drum further having an annular circumferential periphery with at least one row of circumferentially spaced apertures therein and wherein at least a portion of said annular circumferential periphery rotates through said seed supply reservoir, said rotatable drum further having an interior vacuum chamber in communication with a vacuum source such that a suction force draws air through said apertures into said vacuum chamber thereby causing seeds disposed in said seed supply reservoir to be entrained over said apertures by said suction force as said annular circumferential periphery of said drum rotates through said seed supply reservoir;

a seed release disposed in said vacuum chamber and having a portion biased against an interior surface of said annular circumferential periphery such that at least said portion of said seed release substantially covers at least one of said apertures at a time as said drum rotates such that said suction force through said at least one of said apertures is substantially cut off thereby releasing said seeds entrained over said at least one of said apertures.

2. The seed meter of claim **1** wherein said annular circumferential periphery of said rotatable drum is substantially V-shaped in cross-section and wherein each side of said V-shaped annular circumferential periphery includes at least one row of said equally spaced apertures.

3. The seed meter of claim **1** wherein said annular circumferential periphery of said rotatable drum is beveled to one side in cross-section and wherein said beveled annular circumferential periphery includes at least one row of said equally spaced apertures.

4. The seed meter of claim **1** wherein said annular circumferential periphery of said rotatable drum is substantially horizontal in cross-section and wherein said substantially horizontal annular circumferential periphery includes at least one row of said equally spaced apertures.

5. The seed meter of claim **1** further comprising at least one seed stripper disposed in said seed singulation area of said housing for singulating the seeds such that each said aperture entrains only one seed.

6. The seed meter of claim **1** wherein each said apertures includes a web.

7. The seed meter of claim **1** wherein said seed release comprises a rotatable wheel biased against said interior surface of said annular circumferential periphery.

8. The seed meter of claim **1** wherein said seed release comprises a shoe biased against said interior surface of said annular circumferential periphery.

9. The seed meter of claim **8** wherein said shoe has four side walls and a top surface defining an open cavity in said shoe, said open cavity in said shoe disposed in opposition to and substantially sealed against said interior surface of said annular circumferential periphery.

10. The seed meter of claim **9** wherein said shoe further includes a tube to communicate a positive air pressure from a positive air source into said cavity of said shoe such that a positive air pressure is maintained in said cavity, whereby as said apertures in said annular circumferential periphery of said drum rotate under said cavity, said suction force is substantially cut-off by said shoe and said positive air pressure within said cavity forces said entrained seeds from said apertures.

11. The seed meter of claim **1** having a diverter mounted thereto for selectively admitting different seed varieties into said seed reservoir, said diverter comprising:

an adapter having at least first and second compartments, said first compartment in communication with a supply of seeds of a first variety and said second compartment in communication with a supply of seeds of a second variety;

a movable valve disposed in said adapter having at least a first position and a second position, said first position of said movable valve providing communication of said first variety of seeds in said first compartment to said seed reservoir of said housing, said second position of said movable valve providing communication of said second variety of seeds in said second compartment to said seed reservoir of said housing;

an actuator adapted for selectively moving said valve between at least said first position and said second position.

12. The seed meter of claim **11** wherein said actuator is electrically coupled to a switch for manually actuating said actuator.

13. The seed meter of claim **11** wherein said actuator is electrically coupled to a GPS system for automatically actuating said actuator based on preselected field mapping criteria.

14. The seed meter of claim **1** wherein said seed meter is adapted for mounting below a seed hopper of a conventional planter and wherein said released seeds are dispensed into a seed tube operably supported on said planter which in turn directs the released seeds into a seed furrow.

15. The seed meter of claim **1** wherein said seed meter is adapted for mounting rearwardly adjacent a furrow opening assembly and forwardly adjacent a furrow closing wheel assembly of a conventional planter and further whereby said released seeds are dispensed directly into a seed furrow.

16. A rotatable vacuum drum for a seed meter, said rotatable vacuum drum comprising:

a substantially circular first wall adjacently spaced from and a substantially circular second wall;

a substantially V-shaped annular rim sealingly attached to an outer circumferential periphery of said first and second substantially circular first and second walls;

a first row of equally spaced apertures disposed circumferentially along a first side of said substantially V-shaped annular rim;

a second row of equally spaced apertures disposed circumferentially along a second side of said substantially V-shaped annular rim and radially offset from said first row of apertures;

wherein, said first and second substantially circular walls and said substantially V-shaped annular rim define a drum having a vacuum chamber therein, said drum adapted to be rotatably disposed in the seed meter housing, and further wherein said vacuum chamber of said drum is in communication with a vacuum source.

17. The rotatable vacuum drum of claim **16** further having a seed release disposed in said vacuum chamber, said seed release having a portion biased against an interior surface of said V-shaped annular rim such that at least said portion of said seed release substantially covers at least one of said apertures at a time as said drum rotates.

18. The rotatable vacuum drum of claim **16** further having a wiper disposed in close spaced relation to an outside surface of said V-shaped annular rim.

19. The rotatable vacuum drum of claim **16** wherein each said apertures includes a web.

20. The rotatable vacuum drum of claim **17** wherein said seed release comprises a rotatable wheel biased against said interior surface of said V-shaped annular rim.

21. The rotatable vacuum drum of claim **17** wherein said seed release comprises a shoe biased against said interior surface of said V-shaped annular rim.

22. The rotatable vacuum drum of claim **21** wherein said shoe has four side walls and a top surface defining an open ended cavity in said shoe, said opening in said shoe disposed in opposition to and substantially sealed against said interior surface of said V-shaped annular rim.

23. The rotatable vacuum drum of claim **22** wherein said shoe further includes a tube to communicate a positive air pressure from a positive air source into said open cavity of said shoe such that a positive air pressure is maintained in said cavity.

24. An improved agricultural seed planter having a main frame operably supporting a vacuum source and a plurality of spaced row units, each row unit having a row unit frame operably supporting a seed hopper containing a supply of seeds, a furrow opening assembly, and a furrow closing wheel assembly, the improvement comprising:

a) a seed meter, comprising:

i) a housing defining a seed supply reservoir, a seed singulation area and a seed discharge area;

ii) a rotatable drum disposed within said housing, said rotatable drum further having an annular circumferential periphery with at least one row of circumferentially spaced apertures therein and wherein at least a portion of said circumferential outer periphery rotates through said seed supply reservoir, said rotatable drum further having an interior vacuum chamber in communication with the vacuum source such that a suction force draws air through said apertures into said vacuum chamber;

iii) a seed release disposed in said vacuum chamber and having a portion biased against an interior surface of said annular circumferential periphery such that at least said portion of said seed release substantially covers at least one of said apertures at a time as said drum rotates;

b) a feed tube to communicate the supply of seeds from the seed hopper to the seed reservoir of said seed meter;

whereby, as said drum rotates, said suction force through said apertures causes the seeds disposed in said seed supply reservoir to be entrained over said apertures as said apertures rotate through said seed supply reservoir, and further, whereby as said entrained seeds on said drum rotate towards said seed discharge area of said housing, said suction force entraining the seeds over said apertures is substantially cut-off thereby releasing said seeds one at a time from said apertures.

25. The improved agricultural seed planter of claim **24** wherein said annular circumferential periphery of said rotatable drum is substantially V-shaped in cross-section and wherein each side of said V-shaped annular circumferential periphery includes at least one row of said equally spaced apertures.

26. The improved agricultural seed planter of claim **24** wherein said annular circumferential periphery of said rotatable drum is beveled to one side in cross-section and wherein said beveled annular circumferential periphery includes at least one row of said equally spaced apertures.

27. The improved agricultural seed planter of claim **24** wherein said annular circumferential periphery of said rotatable drum is substantially horizontal in cross-section and wherein said substantially horizontal annular circumferential periphery includes at least one row of said equally spaced apertures.

28. The improved agricultural seed planter of claim **24** further comprising at least one seed stripper disposed in said seed singulation area of said housing for singulating the seeds such that each said aperture entrains only one seed.

29. The improved agricultural seed planter of claim **24** wherein each said aperture includes a web.

30. The improved agricultural seed planter of claim **24** wherein said seed release comprises a rotatable wheel biased against said interior surface of said annular circumferential periphery.

31. The improved agricultural seed planter of claim **24** wherein said seed release comprises a shoe biased against said interior surface of said annular circumferential periphery.

32. The improved agricultural seed planter of claim **31** wherein said shoe has four side walls and a top surface defining an open ended cavity in said shoe, said opening in said shoe disposed in opposition to and substantially sealed against said interior surface of said annular circumferential periphery.

33. The improved agricultural seed planter of claim **32** wherein said shoe further includes a tube to communicate a positive air pressure from a positive air source into said open cavity of said shoe such that a positive air pressure is maintained in said open cavity, whereby as said apertures in said annular circumferential periphery of said drum rotate under said cavity, said suction force is substantially cut-off by said shoe and said positive air pressure forces said entrained seeds from said apertures.

34. The improved agricultural seed planter of claim **24** further comprising a diverter for selectively admitting different seed varieties into said seed reservoir, said diverter comprising:

an adapter having at least a first compartment and at least a second compartment, said first compartment in communication with a supply of seeds of a first variety and said second compartment in communication with a supply of seeds of a second variety;

a movable valve disposed in said adapter having at least a first position and a second position, said first position of said movable valve providing communication of said first variety of seeds to said seed reservoir of said housing, said second position of said movable valve providing communication of said second variety of seeds to said seed reservoir of said housing;

an actuator adapted for selectively moving said valve between said first position and said second position.

35. The improved agricultural seed planter of claim 34 wherein said actuator is electrically coupled to a switch for manually actuating said actuator.

36. The improved agricultural seed planter of claim 34 wherein said actuator is electrically coupled to a GPS system for automatically actuating said actuator based on preselected field mapping criteria.

37. The improved agricultural seed planter of claim 24 wherein said seed meter is adapted for mounting below the seed hopper of the planter and wherein said released seeds are dispensed into a seed tube operably supported on the planter which directs the dispensed seeds into a seed furrow.

38. The improved agricultural seed planter of claim 24 wherein said seed meter is adapted for mounting rearwardly adjacent the furrow opening assembly and forwardly adjacent the furrow closing wheel assembly of the planter whereby said released seeds are dispensed directly into a seed furrow.

39. An improved agricultural seed planter having a main frame operably supporting a vacuum source and a plurality of spaced row units, each row unit having a row unit frame operably supporting a seed hopper containing a supply of seeds, a furrow opening assembly, and a furrow closing wheel assembly, the improvement comprising:

a) a seed meter, comprising:

i) a housing defining a seed supply reservoir, a seed singulation area and a seed discharge area;

ii) a rotatable drum disposed within said housing, said rotatable drum having:

A) a substantially circular first wall adjacently spaced from and a substantially circular second wall;

B) a substantially V-shaped annular rim sealingly attached to an outer circumferential periphery of said first and second substantially circular first and second walls;

C) a first row of equally spaced apertures disposed circumferentially along a first side of said substantially V-shaped annular rim;

D) a second row of equally spaced apertures disposed circumferentially along a second side of said substantially V-shaped annular rim and radially offset from said first row of apertures; wherein said substantially circular first and second walls and said substantially V-shaped annular rim define a vacuum chamber in communication with the vacuum source;

b) a feed tube to communicate the supply of seeds from the seed hopper to the seed reservoir of said seed meter;

whereby, as said drum rotates, the vacuum source creates a suction force through said apertures causing seeds disposed in said seed supply reservoir to be entrained over said apertures as said apertures rotate through said seed supply reservoir.

40. The improved agricultural seed planter of claim 39 wherein said seed meter further includes a seed release disposed in said vacuum chamber, said seed release having a portion biased against an interior surface of said V-shaped annular rim such that at least said portion of said seed release substantially covers at least one of said apertures at a time as said drum rotates.

41. The improved agricultural seed planter of claim 39 wherein said seed meter further includes a wiper disposed in the seed meter housing and in a closely spaced relation to an outside surface of said V-shaped annular rim to remove seeds entrained over said apertures.

42. The improved agricultural seed planter of claim 39 wherein said seed meter further includes at least one seed stripper disposed in said seed singulation area of said housing for singulating the seeds such that each of said apertures entrains only one seed.

43. The improved agricultural seed planter of claim 39 wherein each said apertures includes a web.

44. The improved agricultural seed planter of claim 40 wherein said seed release comprises a rotatable wheel biased against said interior surface of said annular circumferential periphery.

45. The improved agricultural seed planter of claim 40 wherein said seed release comprises a shoe biased against said interior surface of said annular circumferential periphery.

46. The improved agricultural seed planter of claim 45 wherein said shoe has four side walls and a top surface defining an open ended cavity in said shoe, said opening in said shoe disposed in opposition to and substantially sealed against said interior surface of said annular circumferential periphery.

47. The improved agricultural seed planter of claim 46 wherein said shoe further includes a tube to communicate a positive air pressure from a positive air source into said open cavity of said shoe such that a positive air pressure is maintained in said open cavity, whereby as said apertures in said annular circumferential periphery of said drum rotate under said cavity, said suction force is substantially cut-off by said shoe and said positive air pressure forces said entrained seeds from said apertures.

48. The improved agricultural seed planter of claim 39 further comprising a diverter for selectively admitting different seed varieties into said seed reservoir, said diverter comprising:

an adapter having at least a first compartment and at least a second compartment, said first compartment in communication with a supply of seeds of a first variety and said second compartment in communication with a supply of seeds of a second variety;

a movable valve disposed in said adapter having at least a first position and a second position, said first position of said movable valve providing communication of said first variety of seeds to said seed reservoir of said housing, said second position of said movable valve providing communication of said second variety of seeds to said seed reservoir of said housing;

an actuator adapted for selectively moving said valve between said first position and said second position.

49. The improved agricultural seed planter of claim 48 wherein said actuator is electrically coupled to a switch for manually actuating said actuator.

50. The improved agricultural seed planter of claim 48 wherein said actuator is electrically coupled to a GPS system for automatically actuating said actuator based on preselected field mapping criteria.

51. The improved agricultural seed planter of claim 39 wherein said seed meter is adapted for mounting below the seed hopper of the planter and wherein said released seeds

are dispensed into a seed tube operably supported on the planter which directs the dispensed seeds into a seed furrow.

52. The improved agricultural seed planter of claim 39 wherein said seed meter is adapted for mounting rearwardly adjacent the furrow opening assembly and forwardly adjacent the furrow closing wheel assembly of the planter whereby said released seeds are dispensed directly into a seed furrow.

* * * * *

US006494154B2

(12) **United States Patent**
Kinzenbaw et al.

(10) **Patent No.: US 6,494,154 B2**
(45) **Date of Patent: Dec. 17, 2002**

(54) **CENTRALIZED SEED DISTRIBUTION SYSTEM FOR PLANTER**

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(73) Assignee: **Kinze Manufacturing, Inc.**, Williamsburg, IA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/903,038**

(22) Filed: **Jul. 11, 2001**

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Related U.S. Application Data

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(51) **Int. Cl.**[7] **A01B 73/04**
(52) **U.S. Cl.** **111/54**; 172/311
(58) **Field of Search** 111/14, 18, 19, 111/20, 22, 24, 34, 52, 53, 54, 55, 63, 73, 186–189, 80, 170, 171, 200, 925

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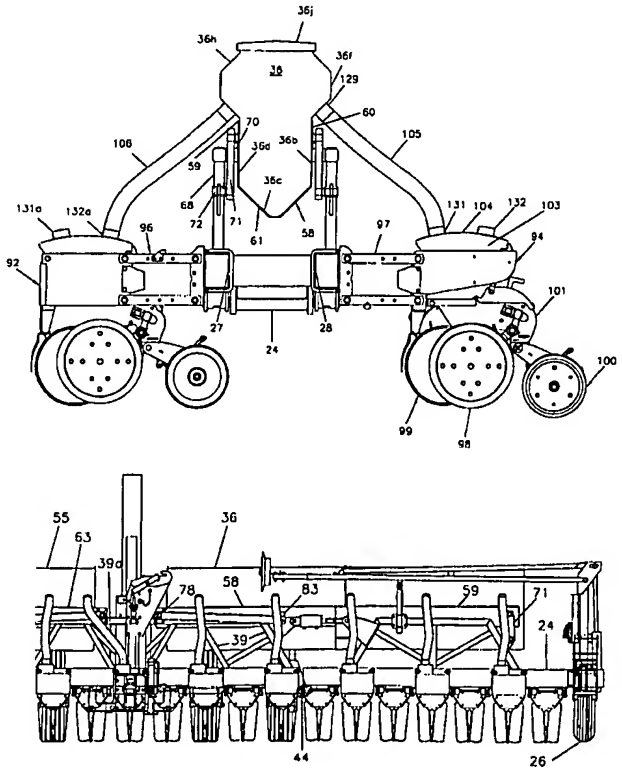
Primary Examiner—Robert E. Pezzuto
(74) *Attorney, Agent, or Firm*—Emrich & Dithmar; James J. Hill, Esq.

(57) **ABSTRACT**

An agricultural planter having left and right hinged wing sections includes seed storage tanks carried by the planter frame and feeding individual row units, mounted fore and aft of the main toolbar, by flexible conduits. The tanks are mounted to permit the wings to flex independently to follow ground contour while extending the tanks from a wing section onto the center frame section.

25 Claims, 17 Drawing Sheets



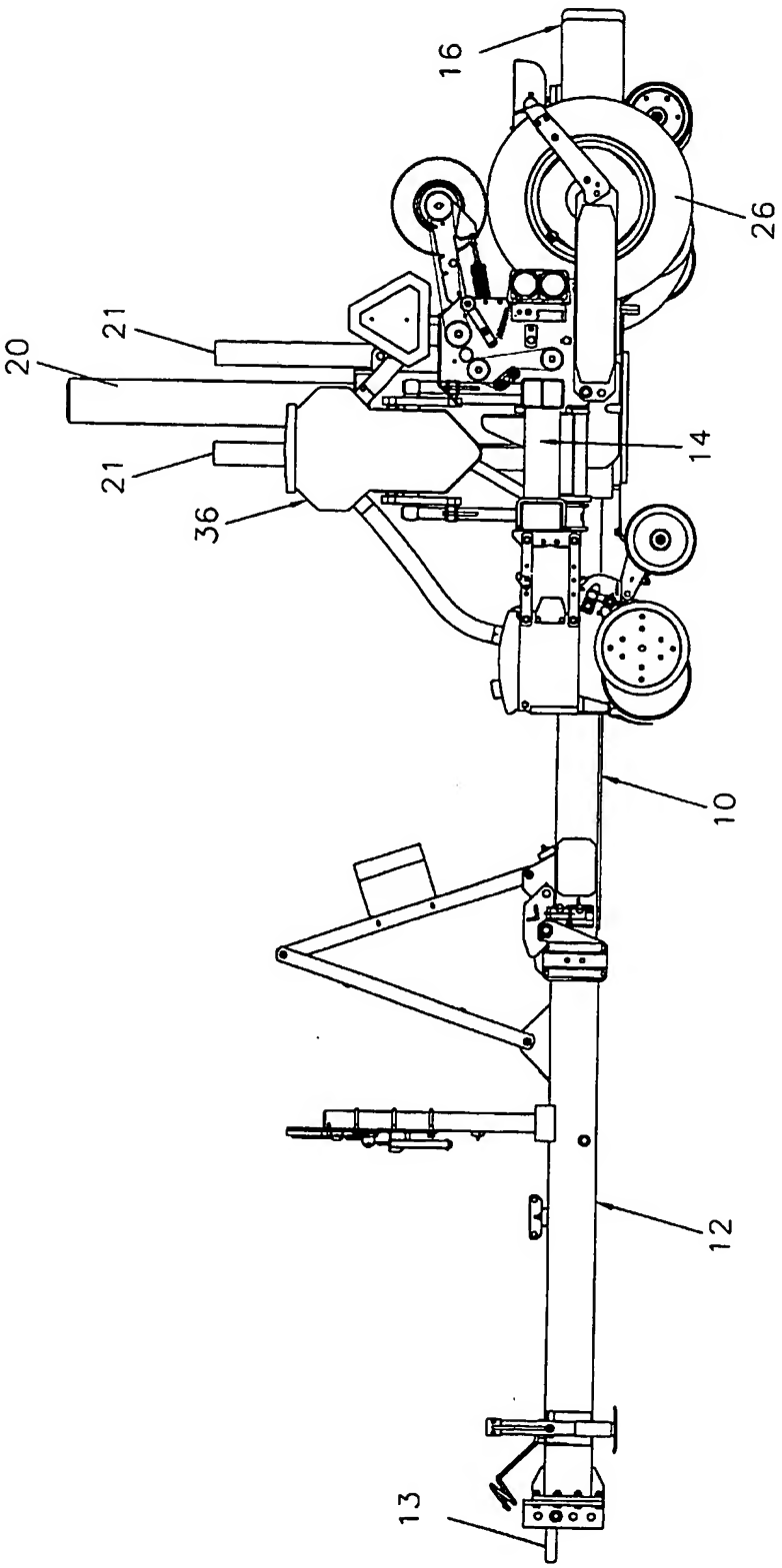


FIG. 1

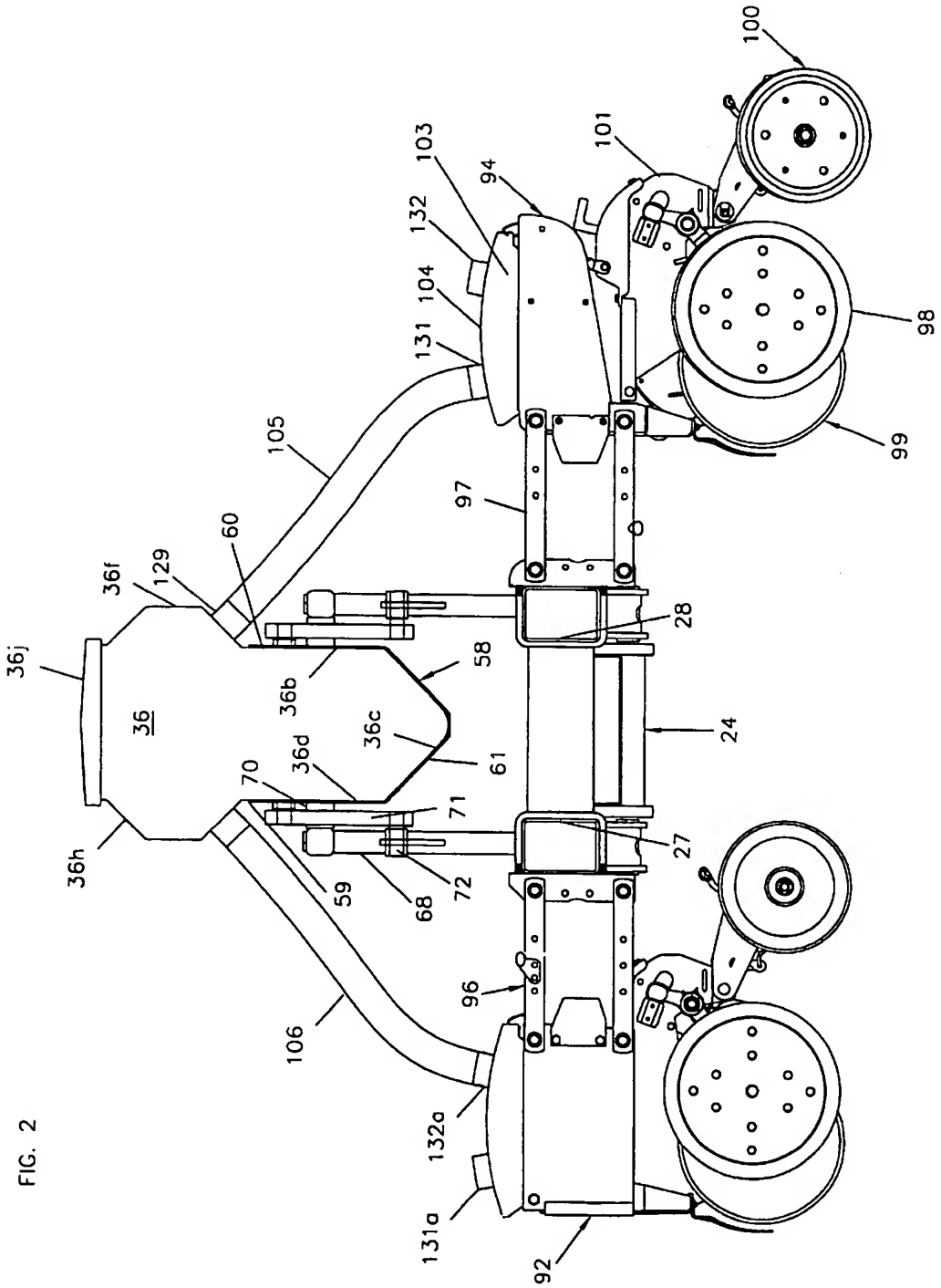

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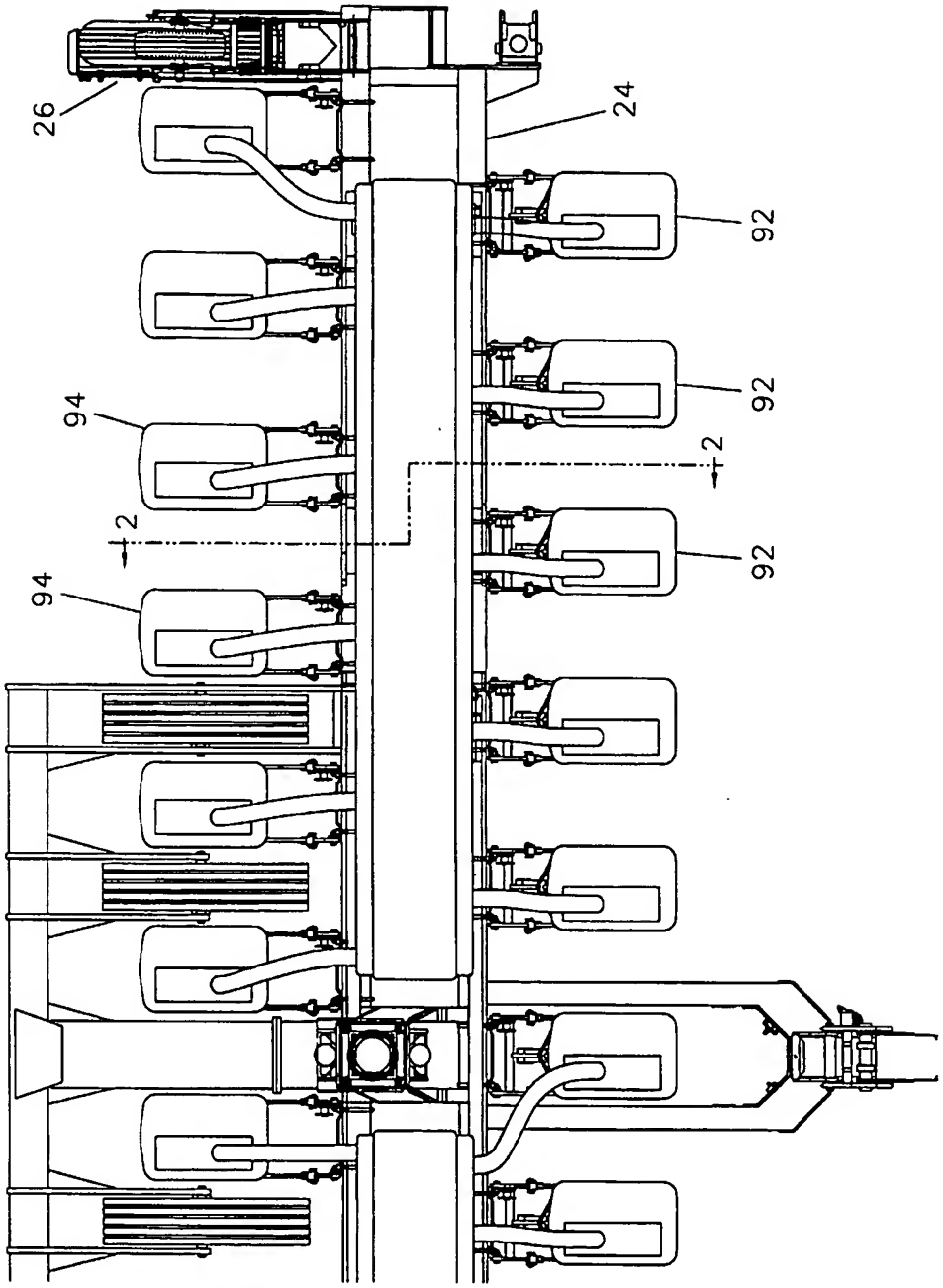
FIG. 2



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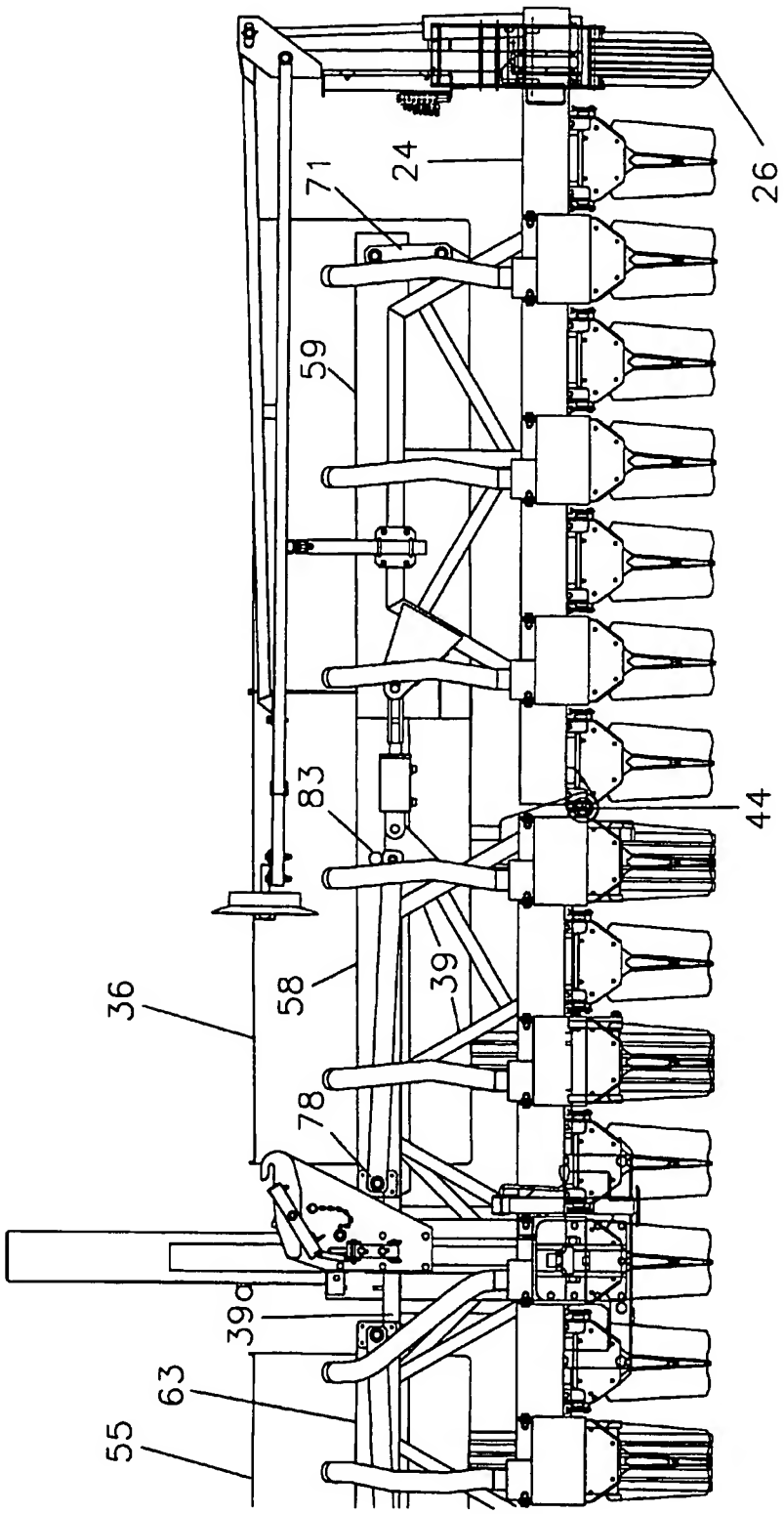

FIG. 4

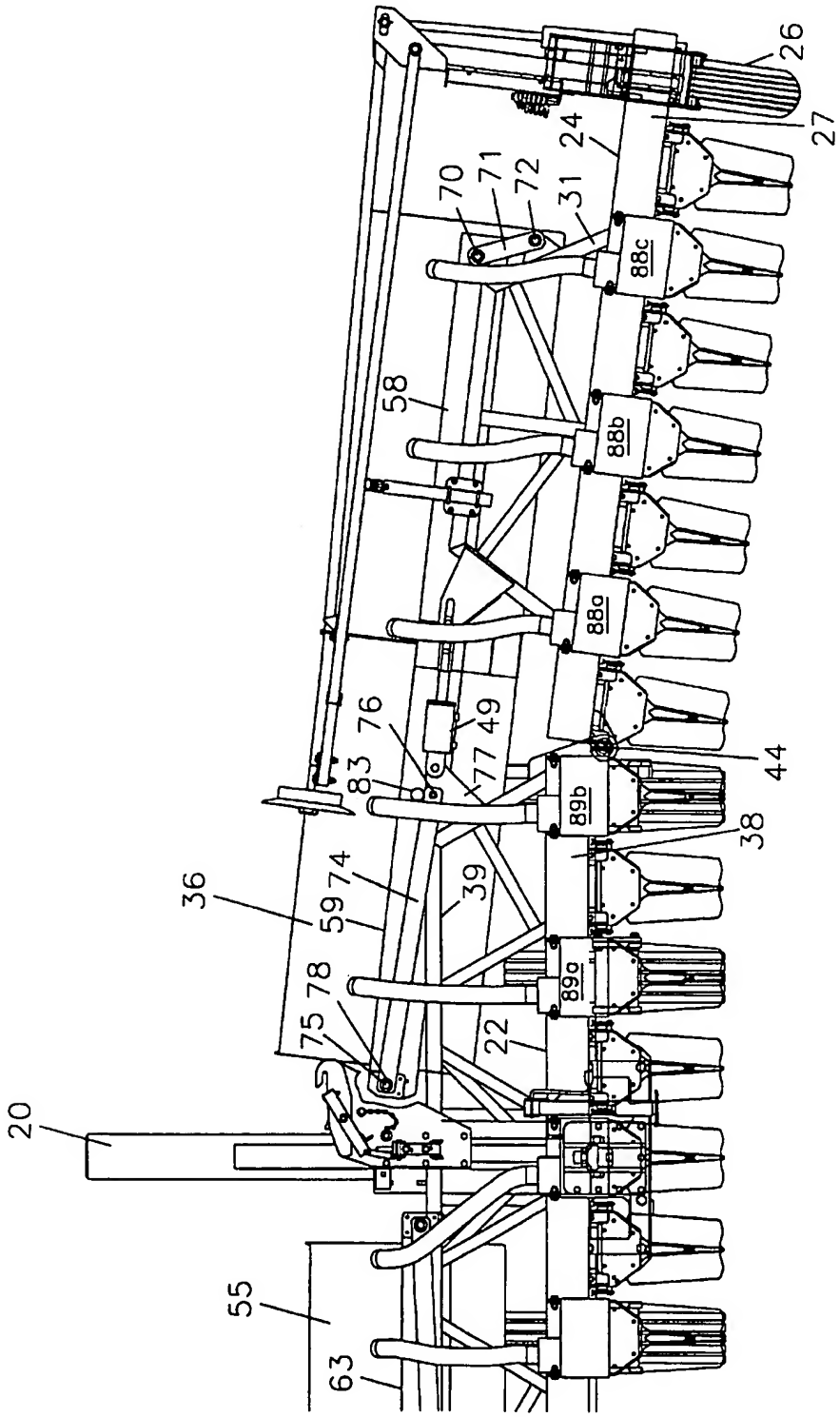
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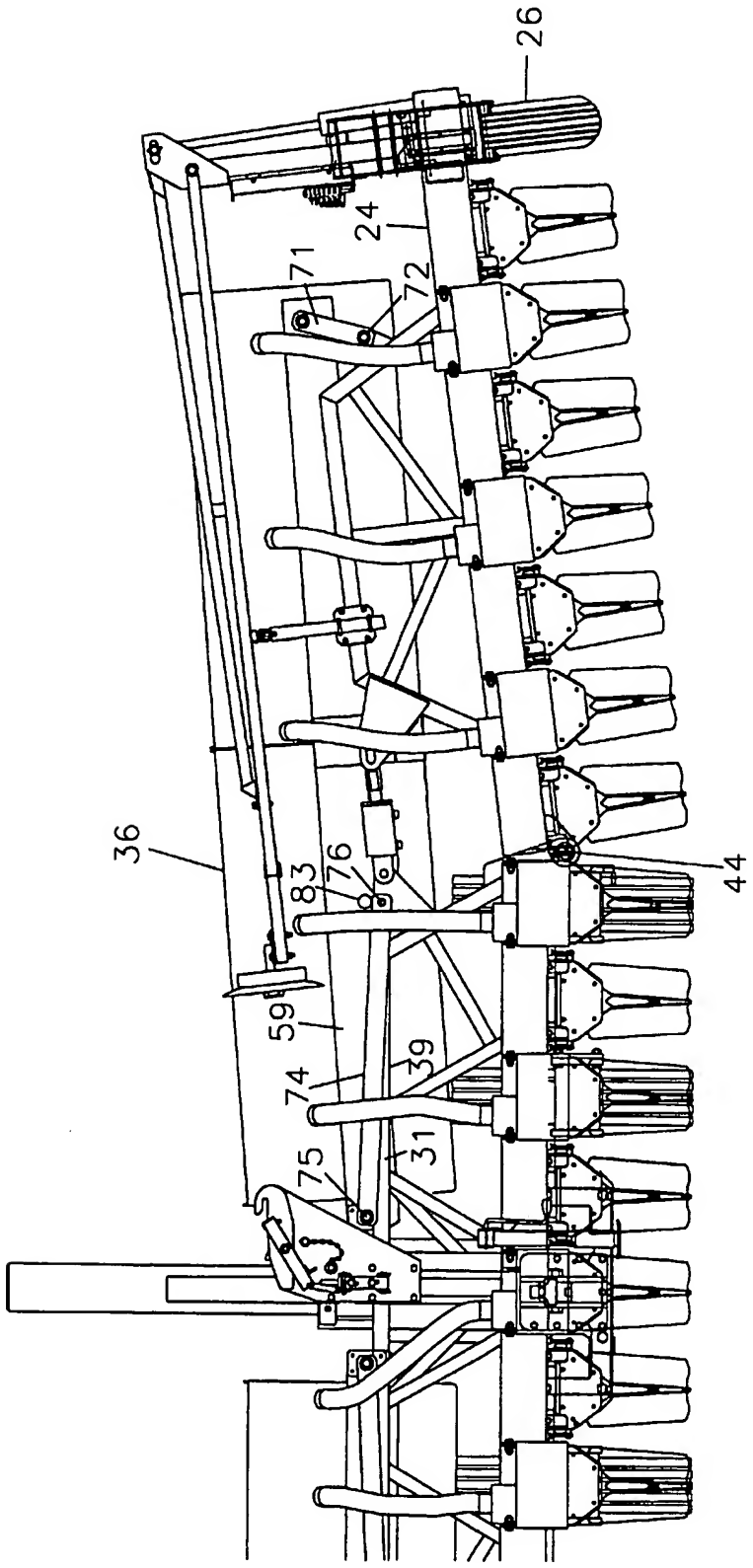
FIG. 5



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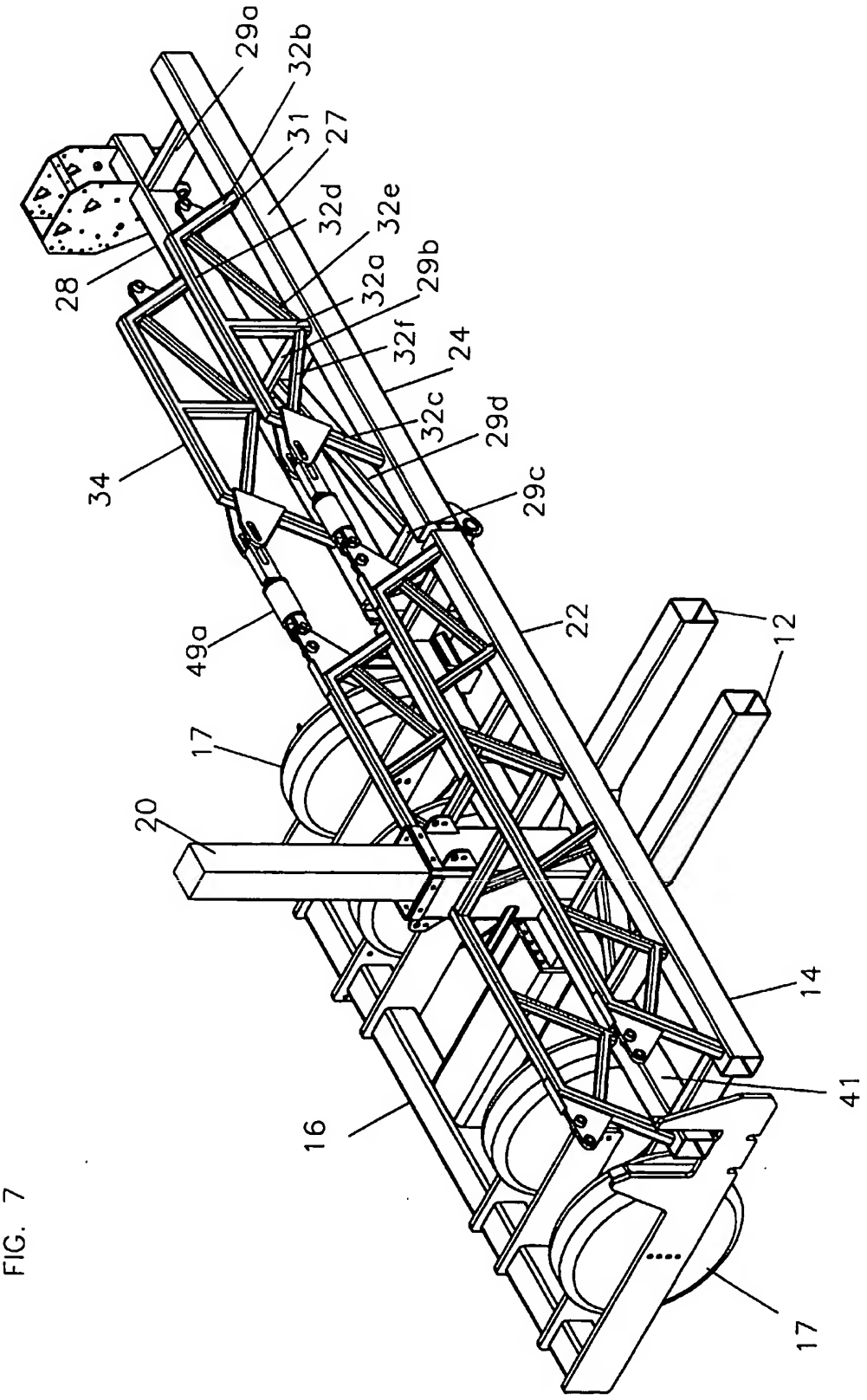
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FIG. 7

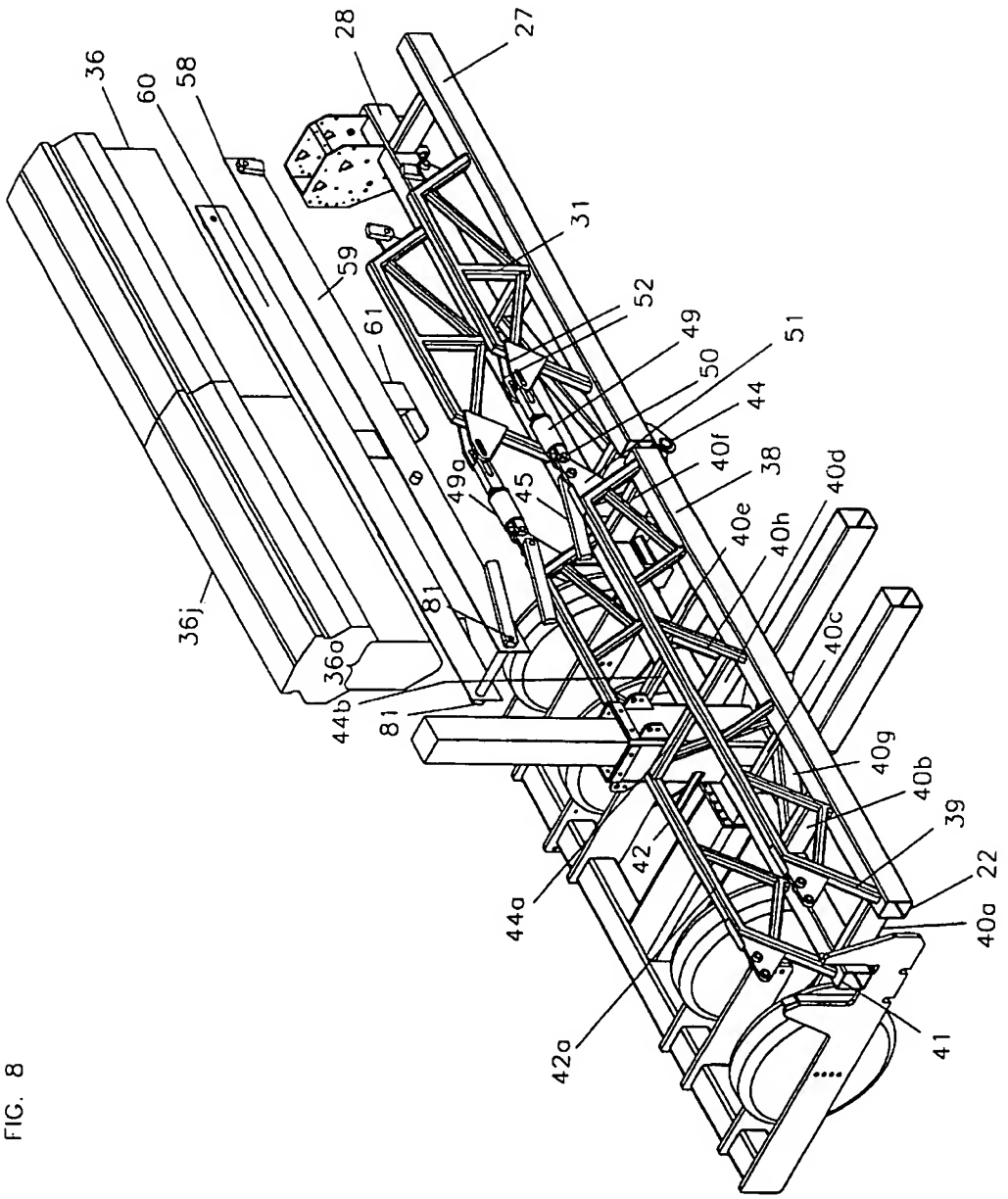
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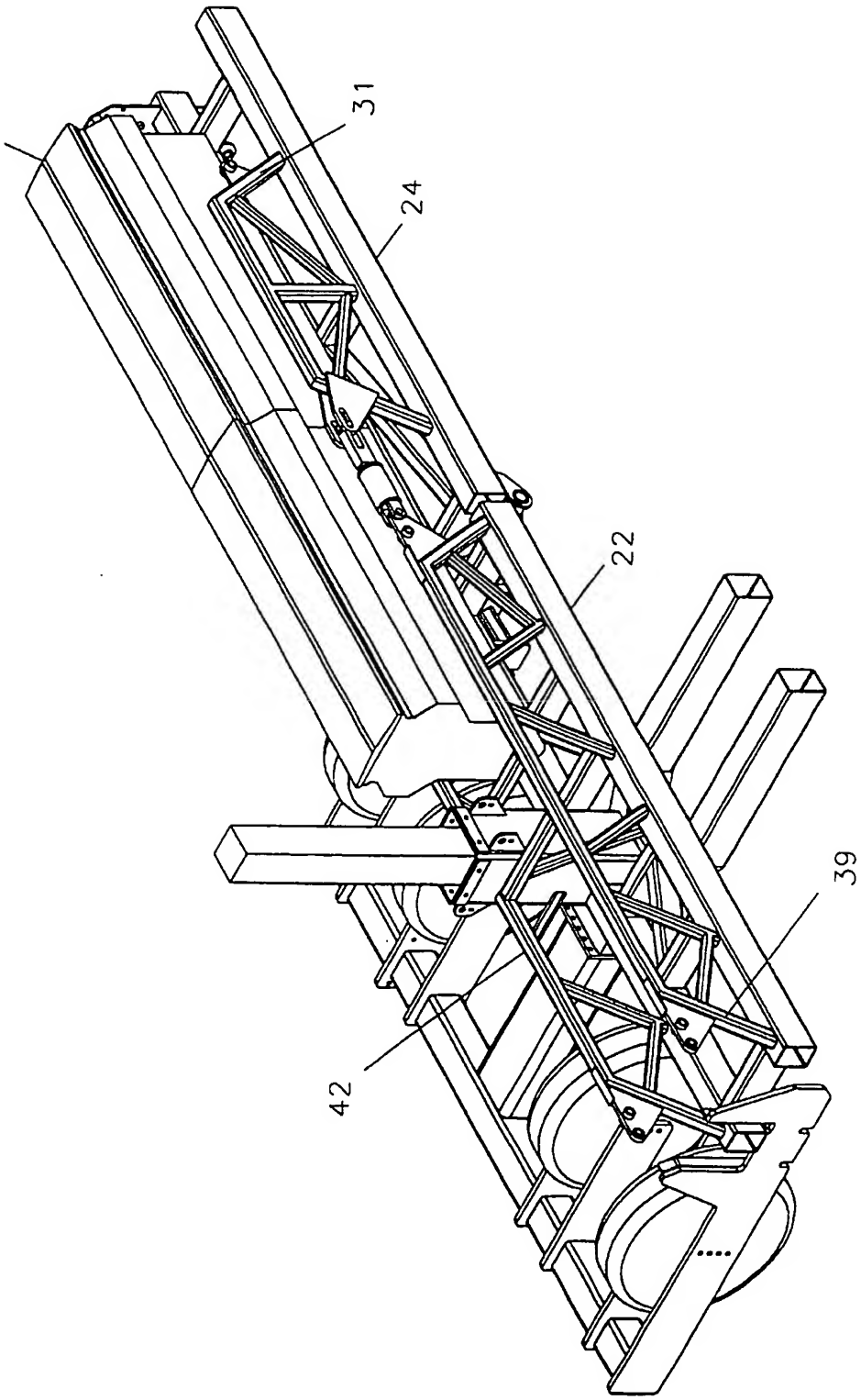
FIG. 8



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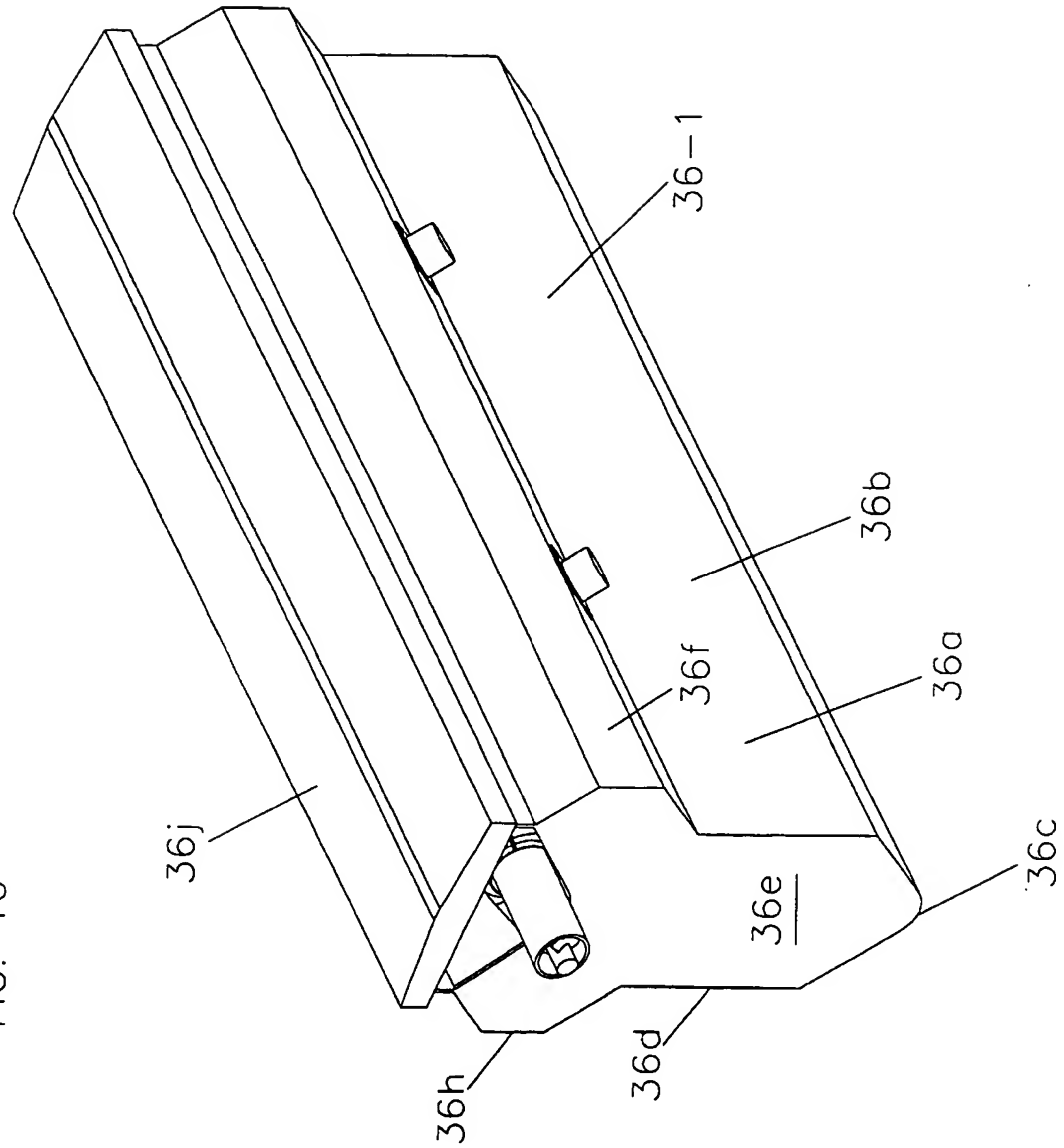
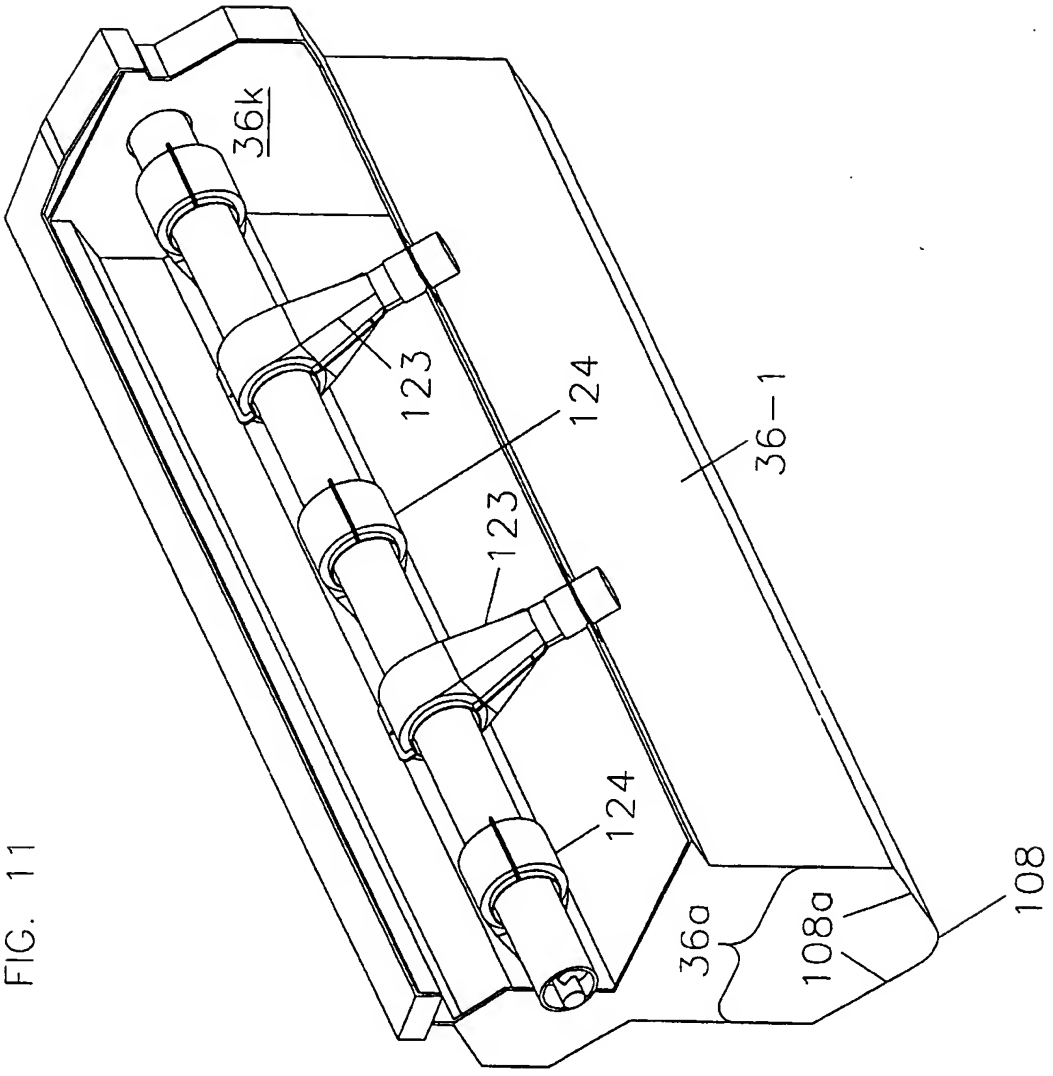


FIG. 10



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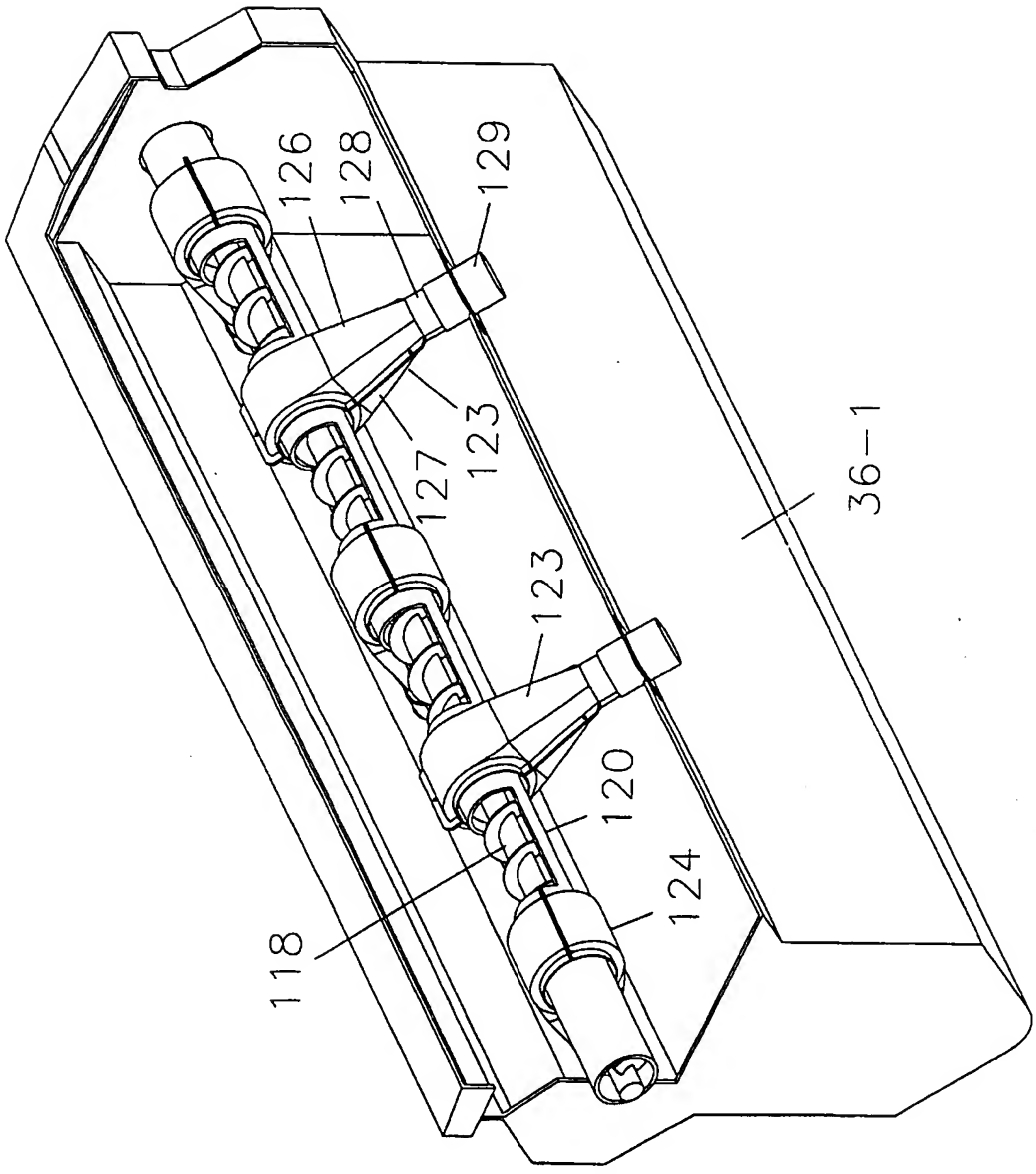
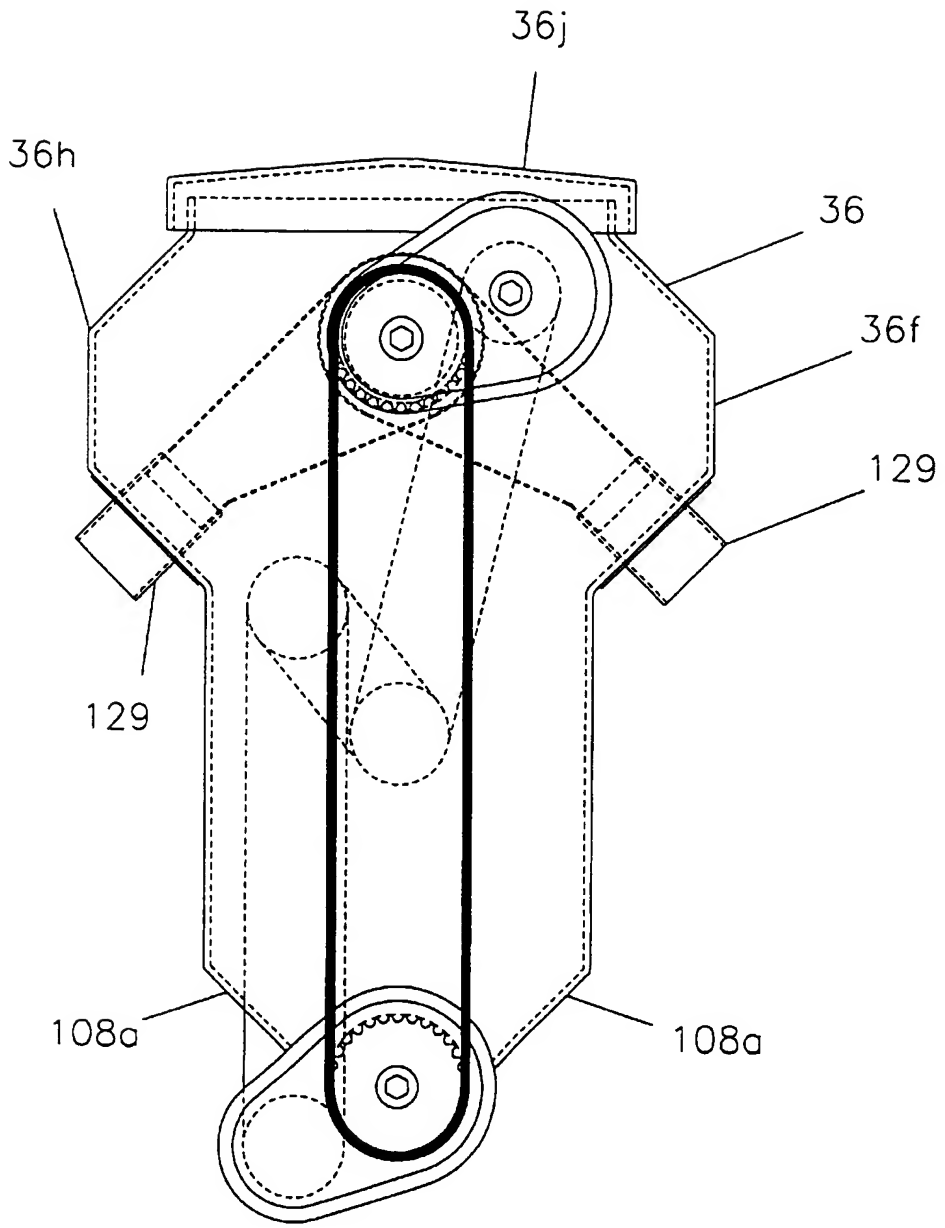


FIG. 12

FIG. 13



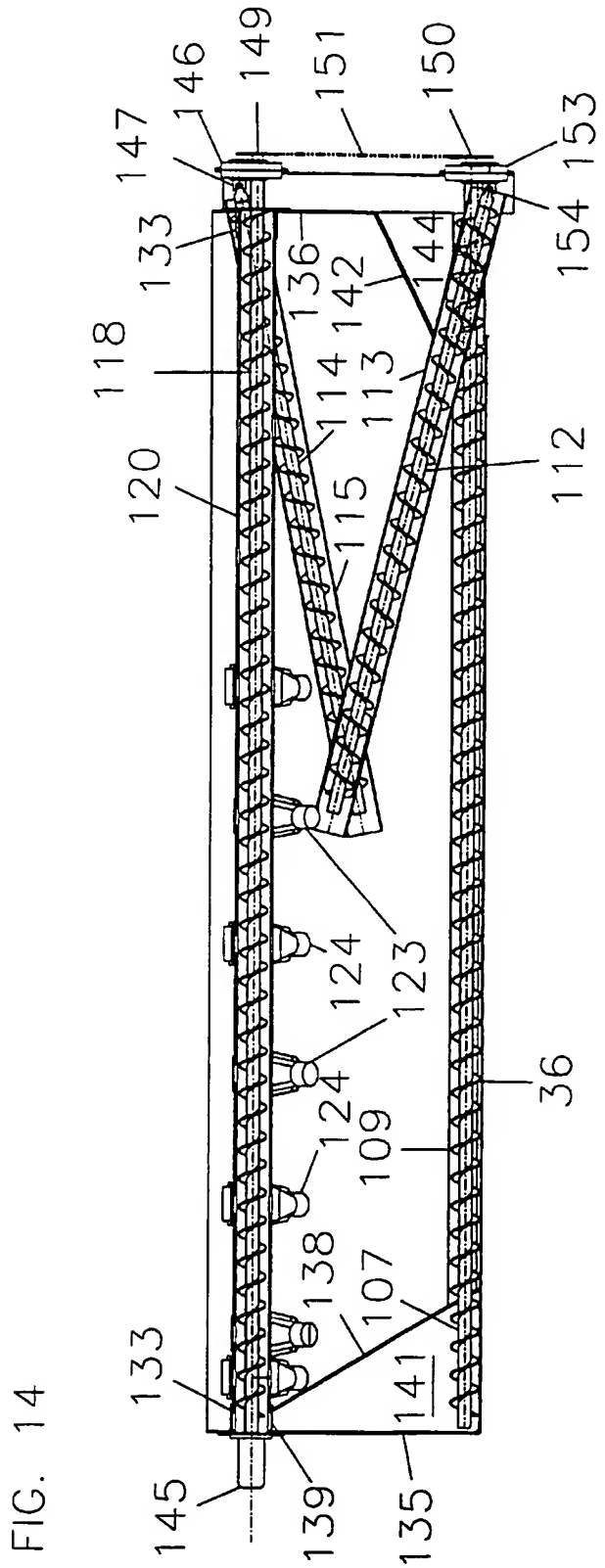

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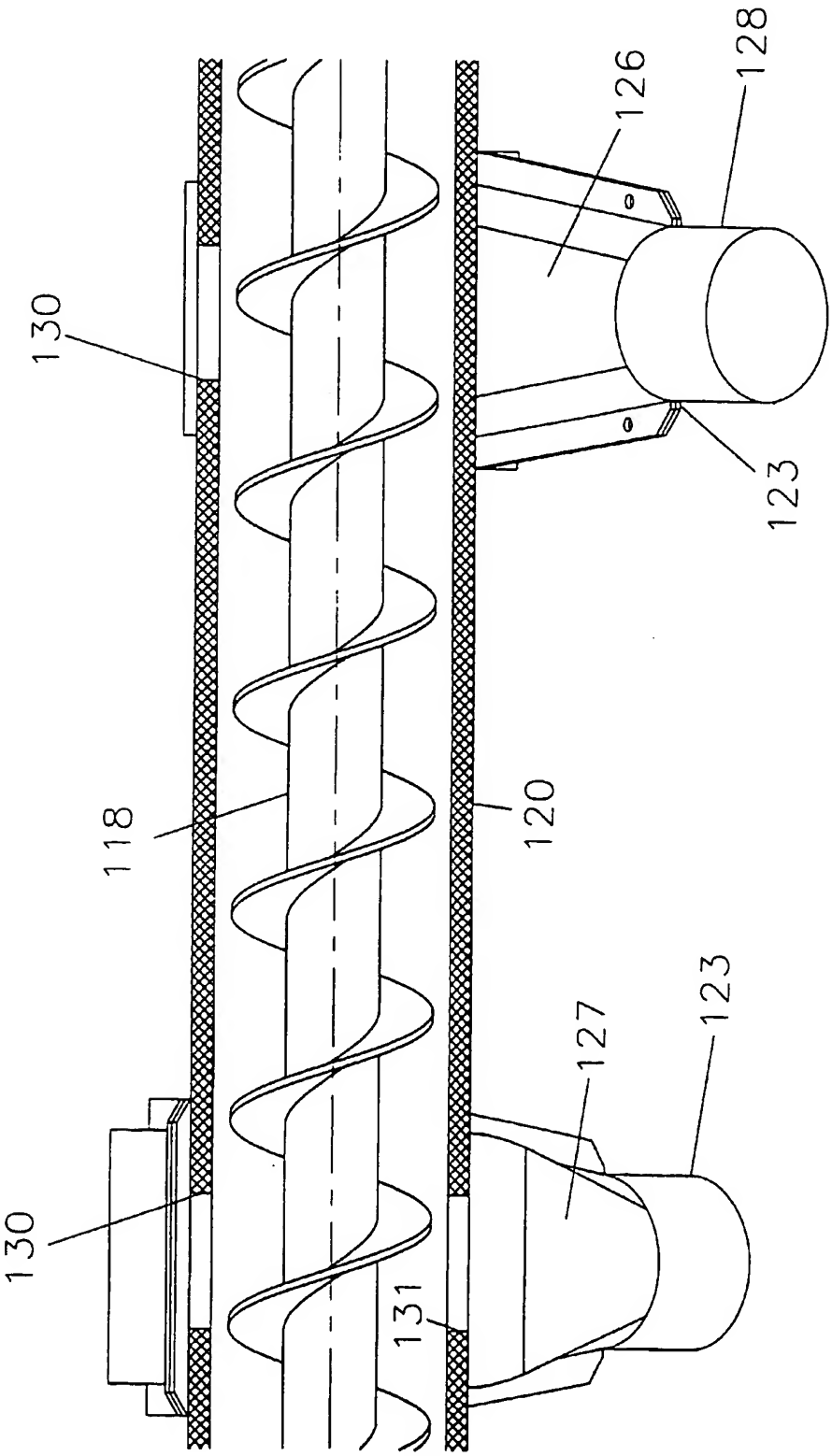
FIG. 14



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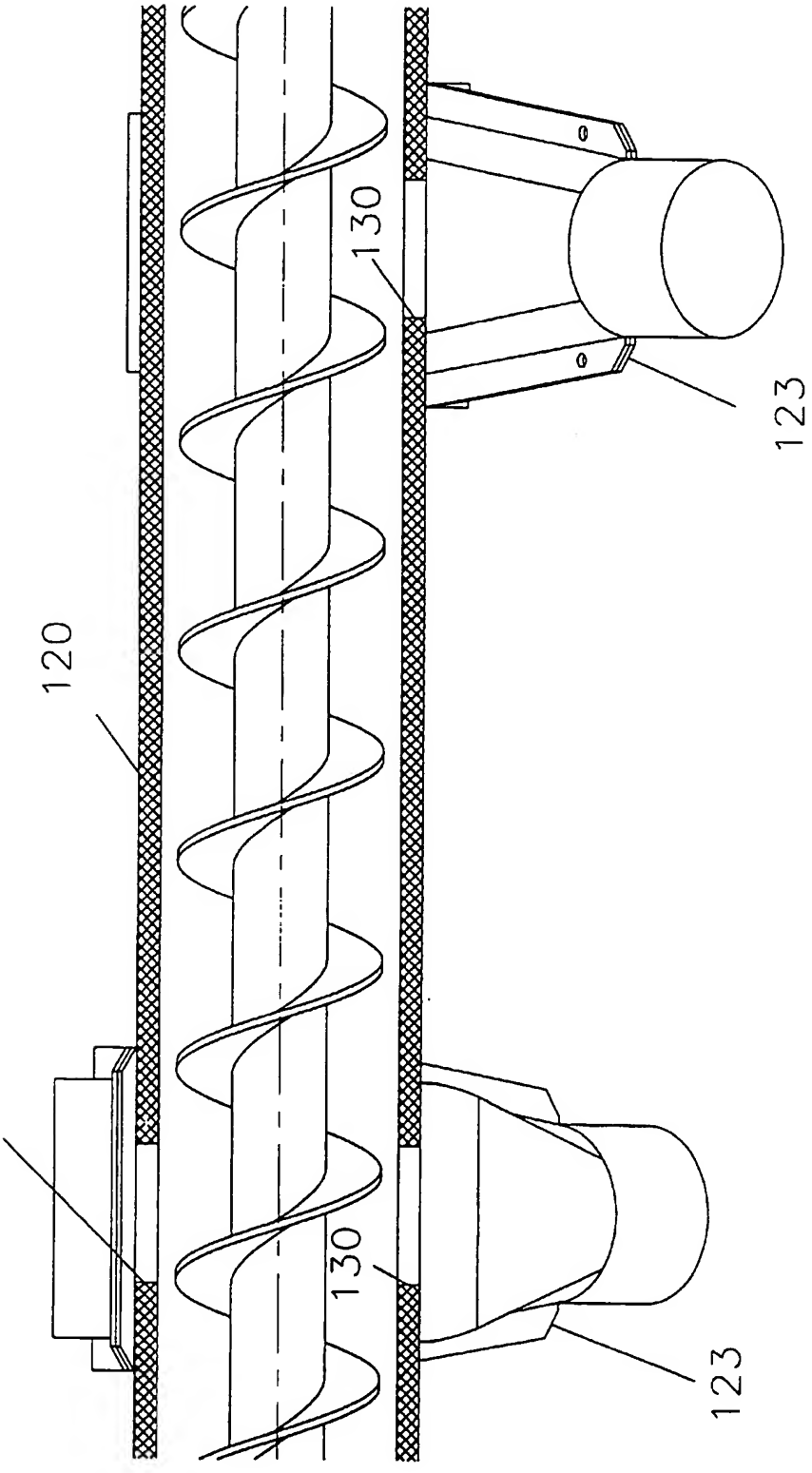
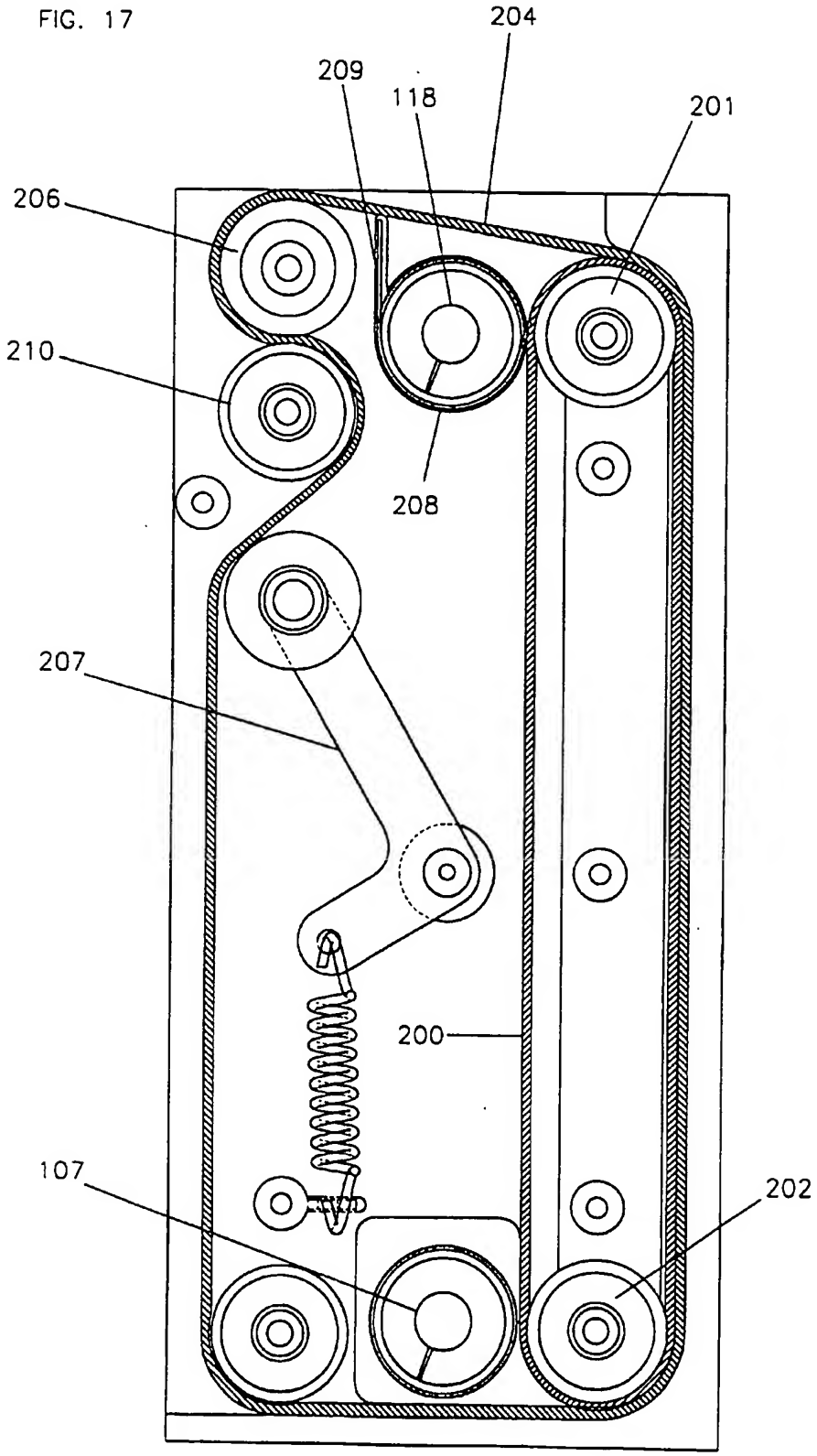


FIG. 16

FIG. 17



CENTRALIZED SEED DISTRIBUTION SYSTEM FOR PLANTER

RELATED APPLICATIONS

This application, pursuant to 37 C.F.R. §1.78(c), claims priority based on U.S. provisional application Serial No. 60/218,230 filed on Jul. 14, 2000.

FIELD OF THE INVENTION

The present invention relates to agricultural planters. Although the illustrated embodiment is in the form of an agricultural row crop planter having multiple frame sections which are hinged together to permit the planter to follow ground contour more closely, the invention has application to single frame planters and to grain drills as well. A row crop planter deposits individual seeds in rows. Typically, a row crop planter has a plurality of "row units" which are independently mounted to a pull frame. Each row unit forms a furrow, deposits separated or "singulated" seeds at a fixed spacing along the furrow and closes the furrow, covering the seed and lightly packing the soil above the seed.

BACKGROUND OF THE INVENTION

A planter row unit, in addition to having a furrow opening device, a seed meter or "singulating" mechanism for separating and depositing individual seeds in the furrow, and a furrow closing device, also typically has a separate hopper (or small tank) to store a supply of seed. A hopper for a planter row unit typically holds about 120 pounds of seed which is generally delivered to the farmer in 50 lb. bags. Seed is stored in the hopper which supplies the seed meter. The seed, upon being singulated by the meter, flows under gravity through a rigid delivery tube into a formed furrow immediately behind a disc furrow opener. The number of acres a farmer may plant with such a system without stopping to refill the hoppers, for a given number of row units and equal seeding rates, is determined by the seed storage capacity of the individual hoppers on the row units.

All of the hoppers on a planter are not necessarily filled with equal amounts of seed. Thus, some row units will run out of seed before others. When a row unit hopper runs out of seed, the farmer is alerted by a monitor normally mounted within the operator's vision on the tractor which displays in real time the "population" or number of seeds being planted per linear unit of measure or per acre. Individual row units have their own sensors and if one row unit runs out of seed, the farmer is alerted immediately. Even though other planter row units may still have seed, the farmer must stop planting and refill all the tanks to reduce the number of stops.

A modern row crop planter may have twelve, sixteen, eighteen or twenty-four row units. It is a very strenuous task to load eighteen empty or nearly empty hoppers using 50 lb. seed bags in the field. The seed bags must be lifted by hand, normally from a pick-up truck, carried to a particular row in the planter; and the farmer must then negotiate between adjacent row units, carrying the seed bag at approximately shoulder level, maneuver the seed bag over the hoppers and dump the seed into the hopper. It frequently happens that the farmer fills one hopper and still may have twenty to forty pounds of seed remaining in that sack, which must be loaded into a seed tank of another row unit or returned to the truck. This exercise can be repeated as many as thirty times to fill a sixteen-row, 30-inch planter with splitter rows.

The example being discussed is not an isolated incident. In fact, farms have become larger with time; and many

farmers plant not only the land they own but rented land as well. The same planter often is used to plant a number of separate fields so that the total acres planted per machine has also increased substantially. Yet, the time for planting obviously remains the same. As a result, seed suppliers have begun delivering seed to the farmer in bulk containers typically holding 1500 to 2000 lbs. of seed. Such large containers require handling equipment, such as forklifts. The trend toward shipping in bulk containers, while reducing cost and saving time, has rendered the filling of individual seed tanks impractical due to difficulties in positioning the handling equipment and controlling the starting and stopping of the seed flow out of the bulk containers when desired, and without spillage.

Another disadvantage with individual seed hoppers is that in order to inspect or repair the seed meter, the hopper and meter must be removed together from the row unit to gain access to the mechanism in the meter. The combination can be heavy to lift, particularly if the hopper is full or nearly full, and the operation can result in spillage of seed or require that the hopper first be emptied.

There are some existing planters which do have centralized storage and distribution of seed. Most such systems use a separate trailing vehicle, namely a drawn cart for storing the seed. The seed is then moved forward to the planter from the rear cart by means of forced air. The seed is then distributed to the individual row, or in the case of seed drill, to the openers. Another commercial planter uses a centralized seed storage tank mounted directly on the planter frame, but the planter frame is rigid. This limits the width of the overall planter to approximately twenty feet (eight rows of thirty inch spacing between adjacent rows). A planter with a rigid frame of twenty feet obviously does not adjust to variations in ground contour as does one with a width of ten feet or less.

A row crop planter of twelve or more rows having a capability of planting at a thirty or thirty-six inch spacing will preferably have three planter frame sections, a center section, a left wing section and a right wing section. The wing sections are articulated respectively to the outboard ends of the center frame section—that is, the wing sections are hinged to rotate independently of one another about horizontal axes parallel to the direction of travel, so that the overall planter frame may follow variations in ground contour more closely. There are currently no commercial row crop planters having a multiple section frame and a centralized bulk seed storage carried directly on the planter frame.

Modem grain drills are typically constructed using a continuous seed tank placed above the furrow openers. A seed metering device is usually attached to the bottom of the tank for each opener, and a flexible hose attached to each seed meter directs the seed flow to the furrow. This generally accepted configuration has some drawbacks. 1). The seed tank must be positioned high enough that there is sufficient room below the seed meter to allow the seed flow hose to flex through the range of motion of the openers. This usually means that some sort of operator platform is necessary for filling the tank with seed. 2). The tanks are generally flat bottomed with holes for mounting seed meters spaced to match the spacing of the openers. When planting row widths of 10–15 in., a considerable amount of seed is left in the tanks between the seed meter openings. Also, the tank must be filled evenly across its length so that all the meters are supplied with seed. As the tank becomes empty, the farmer must stop and rake the seed level across the bottom of the tank to use up all the seed. 3). Farmers frequently change seed varieties as they move from field to field. With current

grain drill designs, it is necessary to drain the tank at each individual seed meter and then sweep out the remaining seed, if left, when changing seed varieties or types.

SUMMARY OF THE PRESENT INVENTION

The present invention includes a row crop planter having a drawn frame supported by wheels. The main frame includes a double toolbar construction (i.e., fore and aft mounting bars) and includes a center section and left and right wings. The center section is supported by wheels; and the outboard ends of each wing is also supported by one or more wheels which may be adjustable in height. As used herein, the term "toolbar" is broadly construed to mean an elongated frame member, extending transversely of the direction of travel, to which individual row units are mounted. Thus, the present invention includes a frame having a forward toolbar and a rear toolbar. Individual push-type row units are mounted by conventional four bar linkages in front of the forward toolbar, and conventional pull-type row units are mounted by four-bar linkages behind the rear toolbar and located between the forward units. If only the rear row units are used, as is typically the case for planting corn, for example, the row spacing may be thirty inches, by way of example. When the planter is set up to plant beans, both the front row units (sometimes referred to as "splitter" units) and the rear units are used at the same time and the inter-row spacing is fifteen inches.

In the illustrated embodiment, the double-toolbar planter frame has a center frame section, a right wing frame section hingedly mounted to the center frame section for movement about a horizontal axis parallel to the direction of travel, and a left frame section similarly mounted to the left side of the center frame section for vertical movement (i.e. articulated) which permits the overall three-section planter to follow ground contour more accurately. Since the individual row units are independently amounted by four-bar linkages, the planting depth for each individual row unit is accurately maintained.

The individual frame sections (that is, left section, center section and right section) are strengthened by means of lattice frameworks extending directly upwardly from each of the forward and rear toolbars for each planter frame section. The toolbars for each planter frame section are further strengthened and formed into an integral frame by means of spaced frame members extending between and welded to the front and rear toolbars.

Thus, each of the center section, right wing section and left wing section includes a frame in the general form of a "U" when viewed from the side, the forward portion of the "U" being formed by the forward upright lattice framework, the rear portion being formed by the rear upright lattice framework, and the bottom being formed by the toolbars and fore-to-aft connecting members.

A storage tank or very large hopper having an open top covered with a removable lid is mounted above each wing frame section, and each seed storage tank is received between and supported by the upright lattice frameworks, fore-and-aft, of each wing frame section. Moreover, the seed storage tanks are elongated in the direction of extension of the wings and they extend inboard of the associated wing pivot joint. That is, the inboard end of each of the seed storage tanks extends into the U-shaped frame of the center frame section, and is supported by the forward and rear upright lattice frames of the center frame section as well as by its associated wing frame section. Each seed storage stores seed for as many as ten or more row units. Each row unit may have a small hopper, called a buffer hopper.

Each seed storage tank is mounted at its outboard end to its associated wing lattice framework, in both the front and rear, by means of a generally upright support link, pivotally mounted at its upper end to the seed tank and pivotally mounted at its lower end to the adjacent upright lattice framework of a wing frame. The inboard end of each seed storage tank is connected, both front and rear, by a generally horizontal link having its outboard end pivotally connected to the adjacent lattice framework of the center section, and its inboard end pivotally connected adjacent the inboard end of the horizontally elongated seed storage tank. The inboard end of each storage tank is provided, both in front and rear, with an inboard pivot support member and an intermediate support pivot member. Thus, each seed storage tank extends along its associated wing section over a major portion of the lateral dimension thereof, and for a substantial portion of the adjacent central frame section.

As a wing section rotates downwardly in adjusting to a downwardly-sloping ground contour, the associated seed storage tank is supported by the intermediate pivot members; and the inboard end of the storage tank is raised slightly above the center section by the intermediate pivot members mounted to the seed storage tank, both front and rear. The intermediate pivot members are arranged to engage, and pivot about the lattice framework of the center frame section, slightly inboard of the hinge location between the wing frame section and the center frame section. The horizontal link connecting the inboard and the tank of the seed storage tank to the framework of the center frame section is in compression, resisting lateral, downward movement of the entire seed storage tank.

When a wing section moves upwardly to adjust to ground contour, the inboard end of the tank is supported by the inboard pivot members located at the inboard end of the seed tank, and the horizontal link is in tension, resisting inward movement of the seed storage tank toward the center of the planter. This support structure and linkages for the seed storage tanks not only permits the tanks to move relative to the row units and the frame sections in order to accommodate variations in ground contour, but it reduces the amount of such motion and makes it possible to mount the seed tanks in low profile above the planter frame which is believed to be of considerable importance and value to the farmer, and it limits the number of seed storage tanks in a multi-section planter to two while increasing their storage capacity by permitting them to extend over, and be supported by, adjacent articulated frame sections.

In this manner, the seed storage tank is permitted limited vertical movement relative to the articulated frame sections, and limited lateral movement, while adjusting to the hinging motions of the adjacent articulated frame sections during use. Moreover, each seed storage tank, one on the right side and one on the left side, is mounted for independent movement relative to the other seed storage tank so that they may independently accommodate the articulating motions of the left and right planter wing sections. Further, the total storage capacity of seed is greatly increased over individual hoppers on row units, and the number of storage tanks is limited to two. Because of the is large size of the storage tanks and the large top opening in each seed storage tank, they are easily loaded by machine to reduce the loading time and effort.

The seed storage tanks are received in, and mounted to, the U-shaped channels formed by the upright lattice frameworks and dual toolbar construction of the planter frame sections. This enables the seed tanks to have a low, attractive profile, yet provide a substantial volume for seed storage. A low tank profile has a number of advantages. First, a low

tank profile provides safety features in that it does not interfere with overhanging gates or other structures when passing. Secondly, the farmer operator has an unobstructed view of the region behind the planter insofar as the height of the tanks is lower than the normal vision line of a farmer operator seated or standing on the tractor. Further, a substantial operational advantage is provided in that the center of gravity for the seed tanks is lower than if the tanks were located further above the planter frame. In addition, the seed storage tanks extend laterally and occupy substantially the entire width of the planter in the field use position. This distributes the weight of the seed tanks (which is substantial when they are full), laterally over the width of the planter while increasing total seed storage capacity.

A seed handling mechanism inside the tanks also provides substantial advantages in operation. The seed handling mechanism within each tank includes an auger conveyor located near the bottom of the tank and extending substantially the entire length of the tank. The length of the floor auger conveyor extends transverse to the direction of travel of the planter. The tank, at its bottom, is narrowed to form a trough to enhance the effectiveness of the floor auger in clearing the tank of substantially all remaining seed. The seed is delivered from the bottom of the tank, by means of an elevator, to an elongated distribution manifold located at the top of each tank and extending longitudinally of the tank. The distribution manifold also contains an auger which conveys the seed longitudinally of the tank. A discharge manifold and flexible connection hose are coupled to the distribution manifold for delivering seed under gravity from the distribution manifold to individual small, closed tanks, sometimes referred to as "buffer hoppers" which supply the seed metering devices associated with each row unit.

Some discharge manifolds extend forwardly and others rearwardly; and they may thus be positioned nearly directly above their associated row units. The discharge manifolds are positioned near the bottom of the elongated distribution manifold so that the flexible delivery hose may remain generally vertical but be routed either slightly forwardly (to supply push-type planter row units) or slightly rearwardly (to supply pull-type planter row units). Thus, locating the seed storage tank at a position above and between the front and rear toolbars of the planter frame not only achieves a more uniform weight distribution for the seed tanks along the planter frame, but it also reduces the lateral distance over which seed is delivered from the distribution manifold to the individual buffer tanks. The upper location of the distribution manifold in the seed tank permits the seed to be delivered from the storage tank to the planting units under gravity, while maintaining the advantages described above of a low profile seed tank structure.

Using the present invention, a grain drill could be constructed with the seed meters located at a high point in the tank, above the bottom. The lift augers would bring the seed up to the meters and evenly distribute the seed to all openers. The delivery hoses would extend to the openers form a position along the bottom of the seed tank, and have enough length to flex with the movement of the opener device. Draining the system to change seed varieties or type could be done with the floor auger. The over-all machine height could be lowered and the function of the machine improved.

Other features and advantages of the present invention will be apparent to persons skilled in the art of the following detailed description of one embodiment accompanied by the attached drawing wherein identical reference numerals refer to like parts in the various views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a left side elevational view of a row crop planter incorporating the present invention;

FIG. **2** is a close up left side view of the planter of FIG. **1** with the wing gauge wheel and row marker removed for viewing the row units and wing frame;

FIG. **3** is a plan view of the left wing section and a portion of the center section of the planter of FIG. **1**;

FIG. **4** is a front view of the left wing section and a portion of the center frame section of the planter of FIG. **1** with the planter on horizontal level ground;

FIG. **5** is a view of the planter similar to FIG. **4** and with the left wing section located on a downward slope;

FIG. **6** is a view similar to FIG. **4** with the left wing section on a lateral upslope;

FIG. **7** is an upper, left frontal perspective view of the planter toolbar frame with the seed tanks removed;

FIG. **8** is a view similar to FIG. **7** with the left seed tank and its metal support in exploded relation relative to the dual toolbars of the center frame section and left wing section;

FIG. **9** is a view similar to FIG. **7** with the left seed tank in assembled relation with the left wing and center section frames;

FIG. **10** is an upper, frontal right side perspective view of a segment of the seed storage tank;

FIG. **11** is a view similar to FIG. **10** with a portion of the seed storage tank cut away to show the distribution manifold and the front and rear discharge manifolds;

FIG. **12** is a view similar to FIG. **11** with upper sections of the distribution manifold removed to show the distribution auger;

FIG. **13** is an end view, partly in diagrammatic form, of a seed storage tank;

FIG. **14** is a longitudinal, vertical rear cross-sectional view of the right seed storage tank with the auger conveyor housings and distribution manifold also in vertical section;

FIG. **15** is a vertical, cross-sectional view of a portion of the distribution auger taken parallel to the axis of the distribution manifold and with the distribution manifold rotated to the position for distributing only to the rear row units;

FIG. **16** is a longitudinal, vertical cross-sectional view of the distribution manifold similar to FIG. **15**, but with the distribution manifold rotated to distribute seed to both the front row units and the rear row units; and

FIG. **17** is an end view of an alternate belt elevator for raising seed from the floor auger to the upper distribution conveyor.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring first to FIG. **1**, there is shown an agricultural row crop planter generally designated **10**. The planter **10** includes an extendable hitch tongue generally designated **12** which is adapted to be connected to a tractor by means of a hitch **13**. The tongue **12** is shown in FIG. **1** in the retracted position, but as known in the art, it may be extended or elongated so that a lift frame carrying the planter row units, to be described, and generally designated **14** may be raised from the field use position shown in FIG. **1** and turned ninety degrees (i.e., parallel to the plane of the page of FIG. **1**) so that the planter lift frame extends longitudinally in the direction of travel of the tractor. This narrows the configuration for road transport.

The rear end of the tongue **12** is rigidly affixed to an axle assembly generally designated **16**. The axle assembly **16** carries the main axle on which the ground support wheels **17** for the axle assembly and center frame section are mounted.

Also mounted on the axle assembly is an upright post **20** having a generally rectangular cross-section. The lift frame **14** (see FIG. **7**) is comprised of toolbar frames for the center section and both wing sections, as will be further described. The lift frame **14** is slidingly received on the upright post **20** and it may be raised vertically, guided by the post **20** and lifted by hydraulic cylinder **21** to the raised position. When it is desired to arrange the planter for transport, the lift frame is turned by an hydraulic cylinder a quarter turn from the field use or planting position (seen in FIG. **3**) by rotating the post **20** so that the lift frame extends longitudinally in the direction of travel for road transport. The tongue **12**, of course, is in the extended position for road travel; and it is seen in FIG. **1** in the retracted position, tropically used for planting.

What has been described thus far in connection with the drawing is known and corresponds substantially to the implement covered by U.S. Pat. No. 5,346,019 entitled "Agricultural Implement with Common Mechanism for Raising/Lowering and Rotating a Lift Frame about a Vertical Axis."

The lift frame **14** has three sections, a center section designated **22** in FIG. **7**, a left wing section **24** (FIG. **7**), and a right wing section generally designated **25** in FIG. **4**. Each of the wing sections **24**, **25** are similar, in mirror image, so that only one need be described in detail for a complete understanding of the invention. What is present in one wing section is also present in the other, unless noted otherwise.

Referring to FIG. **7**, the left wing section **24** includes a forward mounting bar **27**, also referred to as a "toolbar," and a rear toolbar **28**. As will be described, forward or "push-type" planter row units (**92** in FIG. **2**) are mounted on the forward toolbar **27** and "pull" planter row units (**94** in FIG. **2**) are mounted on the rear toolbar **28** in a conventional manner. The outboard end of each wing section is supported by a conventional gauge wheel assembly (see the left gauge wheel **26** in FIGS. **1** and **3**, but which is removed from FIG. **2** for viewing the frame and row units).

The toolbars **27**, **28** are parallel and extend transverse of the direction of travel in the field use position, and they are formed into a rigid frame by means of intermediate frame connecting members, **29***a*, **29***b* and **29***c* in FIG. **7**. Additional structural integrity may be provided by a diagonal frame member **29***d*.

Mounted to the top of the forward toolbar **28** is a forward, upright lattice framework generally designated **31**. The lattice framework **31** includes an upright center member **32***a*, an outboard member **32***b* which is generally upright and slightly inwardly inclined, an inboard member **32***c* which extends upright and slightly outwardly, a horizontal top member **32***d* which is welded to the tops of the members **32***a*, **32***b*, **32***c*; and diagonal brace members **32***e*, **32***f*, which are affixed respectively between the upright center frame member **32***e* and the inclined outer member **32***b* and inclined inner member **32***c* forming the upright lattice for framework **31**. The configuration of the constituent members of the various frames disclosed herein are not critical as persons skilled in the art will appreciate; and alternate configurations will be useful to perform the purposes of those disclosed.

A similar upright lattice framework generally designated **34** is mounted to the top of the rear toolbar **28** of the left wing section frame **24**.

It will be appreciated that the forward and rear toolbars **27**, **28** together with the intermediate frame members **29***a*–**29***c* and diagonal frame member **29***d*, and the forward upright lattice frame **31**, and rear upright lattice framework **34** form a bridge or U-shaped channel (when viewed from the side) which permits a seed storage tank, such as the one generally designated **36** in FIG. **8**, to be mounted to the upper portions of the lattice frameworks and be carried by this bridge structure, as will be further discussed below.

Turning now to the center frame section **22** as seen in FIG. **8**, it includes a forward toolbar **38**, to the top of which is mounted an upright lattice framework generally designated **39**, and a rear toolbar **41** to the top of which is affixed a rear upright lattice framework generally designated **42**. The forward and rear toolbars of the center section are formed into a rigid frame by means of longitudinal connecting members **40***a*–**40***f*, as well as diagonal frame members **40***g*, **40***h*. The seed tanks each overlap the hinged juncture between the center section and the associated wing section, and extend substantially all the way to the center of the machine. The forward upright lattice framework **39** and the rear upright lattice framework **42** of the center section are also braced by inboard upper longitudinal frame members **44***a*, **44***b*, which are fixed respectively between the upper horizontal frame member of the lattice framework **39** and **42***a* of the rear upright lattice framework **42** of the center section adjacent to the lift post **20**.

Each of the wing section frames is hinged to the adjacent end of the center section frame so that the wings may rotate or articulate in a vertical direction independently of one another. The pivot connection between the forward toolbar **27** of the left wing section **24** and the forward toolbar **38** of the center frame section is shown at **44** in FIGS. **4** and **8**. A corresponding pivot (rotatable on a common axis) is located between the rear toolbar **28** of the left frame section and the rear toolbar **41** of the center frame section. Corresponding fore-and-aft pivots with their rotational axes aligned to form a hinge and extending in the direction of travel of the planter, are provided between the right side of the associated forward and rear toolbars of the center frame section and the right wing section.

Still referring to FIG. **8**, the adjacent portions of the forward upright lattice framework **31** of the left wing section and the forward upright lattice framework **39** of the center frame section are joined by an hydraulic cylinder unit **49**. The case or cylinder end of the hydraulic cylinder unit **49** is pivotally connected at **50** to a mounting bracket **51** fixed to the adjacent side of the forward lattice framework **39** of the center section. The rod end of the cylinder carries a pin received in slots in a pair of brackets **52** mounted on the forward lattice framework **31** of the left wing section **24**. As is known in the art, when the cylinder **49** is retracted, the left wing section **24** is prevented from flexing downwardly, and when the cylinder **49** is extended, the left wing section may pivot both upwardly and downwardly relative to the horizontal, but within limits defined by the slots in the mounting brackets **52**. A similar hydraulic cylinder unit **49***a* is connected between the rear upright lattice frameworks of the center frame section and left wing section, respectively. Corresponding hydraulic cylinders (not seen in the drawing) are provided to connect the upper portions of the lattice frameworks for the forward and rear toolbars of the right frame section to the forward and rear lattice frameworks of the center frame section and they operate in the same manner as described in connection with the left side cylinders **49**, **49***a*.

As seen in FIG. **8**, the left seed tank **36** is of a shape which permits it to be received between the forward and rear upright lattice frameworks of the forward and rear toolbars for the center frame section and the left wing frame section. Specifically, the seed tanks extend across the hinges con-

necting the wing sections to the center frame section (see FIG. 5). The inboard ends of the two seed tanks 36, 55 (for the right side of the planter) extend well into the center section and their inboard ends are spaced adjacent the center lift post 20 (see FIG. 4).

To reduce cost, the seed storage tank 36 may be fabricated from two individual and identical boxes such as the one designated 36-1 in FIGS. 10–12, with adjacent end walls removed to make one continuous storage tank 36 having a continuous, completely open top covered by a cover 36*j*. Making smaller boxes (e.g., having a length of six feet) reduces manufacturing and tooling costs and permits the same smaller boxes to be joined to form tanks even larger than the two-unit tank 36, such as twelve or eighteen feet by joining them together and removing internal walls. The structure of the tanks is shown in diagrammatic form in FIGS. 4 and 5, and will be understood by those skilled in the art, however, from a subsequent description of FIGS. 10–12.

Turning now to the seed storage box 36-1 as seen in FIG. 10 (see also FIG. 2), it includes a lower central portion 36*a* formed by a front wall 36*b*, a trough-shaped bottom wall 36*c*, a rear wall 36*d* and left and right end walls, the right or inner end wall being shown in FIG. 10 and designated 36*e*. The other end wall, designated 36*k* in FIG. 11 is removed when joined to another tank section to form the complete tank.

Above the upright front and rear walls 36*b*, 36*d*, the seed storage tank 36 flares upwardly and outwardly, forming a forward extension (or overhang) generally designated 36*f* and a rearward extension (or overhang) 36*h*, each of which extend the full length of the tank and overhang the lattice frames. The top of the tank 36 is formed into an inlet opening, covered by the cover 36*j*.

Referring now to FIGS. 2 and 8, the lower, reduced central portion 36*a* of the tank 36 is received in and supported by a metal support generally designated 58. The metal support 58 includes front and rear laterally elongated bands 59, 60, joined at their center by a strap 61 which extends beneath the center portion of the tank and conforms to the trough shape of the narrowed lower portion 36*a* of the seed storage tank. The right seed storage tank 55 is similarly constructed, supported and mounted, but in mirror image. The metal support 58 is part of the tank and could be eliminated if the storage tanks were made of metal but that may be too expensive. Further, the metal support could be inside the tank and fastened to the tank from within.

Each of the seed tanks is similarly mounted, front and rear. Reference is made to FIGS. 5–8 which show the front mounting for the left storage tank 36. For the right side seed tank 55, the associated metal support is designated 63 in FIG. 4. The left side wing section 24 is seen in FIG. 5.

The left side or outboard end of the horizontal elongated band 59 of the metal support frame 58 for the left side seed tank 36 is pivotally connected at 70 to a link 71 (sometimes called the vertical or upright link), the other end of which is pivotally connected at 72 to the left side of the front upright lattice framework 31 of the front toolbar 27 of the frame for the left wing section. Adjacent the inboard end of the band 59 of the metal support 58, a generally horizontal link 74 is pivotally connected at 75. The left side of the link 74 is pivotally connected at 76 to a bracket 77 mounted to the left side of the upright lattice framework 39 of the front toolbar 38 of the center section.

The rear of the seed tank 36 is similarly mounted by an upright link similar to link 71 to the rear upright lattice framework of the left wing section and, at the inboard end of the seed tank, the rear of the seed tank is connected to the rear upright lattice framework 39 of the center section frame by means of a generally horizontal link similar to link 74.

As will be described further below, the function of the upright links (e.g. 71) is primarily to support the outboard end of the seed tank and its contents and to transfer weight to the wing frame, and thence to the wing gauge wheel, while permitting the outboard end of the seed tank to move slightly laterally. The horizontal fixing link 74, however, does not operate in the same manner as the upright support link.

Still referring to FIGS. 4–6, the right or inboard pivot 75 of the horizontal link 74 includes a sleeve or tube 78 (FIG. 4) which is welded to the link 74 and extends rearwardly above the upright rear lattice framework 42 of the center frame section and rests on a top horizontal member 42*a*. The sleeve 78 extends above the top member 42*a* and rests on it for certain positions of the left side wing seen in FIGS. 4 and 6. The sleeve 78 acts as a rolling pivot or fulcrum when the wing is raised, as in FIG. 6.

A second stop or pivot 83 is fixed to the horizontal rear band 58 of the metal support 59 and extends forwardly above the horizontal top member 39 of the rear upright lattice framework, just described, and rests on the top of the bracket 77 to form a pivot support for the positions of the right wing shown in FIGS. 4 and 5 (i.e., wing horizontal or lowered). Corresponding support members (i.e., sleeves or rods) for the inboard pivot support members 78, 83 are provided for the rear of the left seed tank 36 as well as for the front and rear metal bands of the support for the right seed storage tank 55. Moreover, a corresponding intermediate pivot support is provided for the right seed tank 55 similar to those which have been described, but in mirror image, and they function as will presently be described in connection with the left side wing structure.

The outboard end of the left wing section 24 is supported by a conventional gauge wheel generally designated 26 in FIGS. 5 and 6. The inboard end of the wing section is supported by the hinge connection 44 to the center frame section which, in turn, is supported by the previously described wheels 17 mounted on the main axle assembly 16.

As the planter traverses the ground, the left wing section 24 is free, within the limits described above, to remain horizontal, as shown in FIG. 4, or to flex upwardly as shown in FIG. 6, or to flex downwardly as shown in FIG. 5. The flexure depends upon the elevation of the ground being traversed by the wing gauge wheel 26 relative to the ground level being traversed by the support wheels of the center section, as persons skilled in the art will appreciate.

Referring particularly to FIG. 4, when the outboard left side gauge wheel 26 is traveling on ground at the same elevation as the ground on which the main support wheels 17 are located, the left side seed tank 36 remains at the same elevation as the left wing section frame, and the bottom surface of the seed storage tank remains horizontal at a substantially constant distance above the ground. The outboard end of the seed storage tank 36 is supported by the link 71 which is in a substantially vertical position when the wing is on level ground, as seen in FIG. 4. The inboard end of the seed tank 36 is supported by the pivot support 78 resting on the horizontal top member 40*g* of the front upright lattice framework 35 of the center section frame and a corresponding, aligned pivot support member on the rear of the seed tank. The front side of the tank is similarly supported by a sleeve or rod pivot member 83 resting on the front lattice framework 35 of the center section frame in the

horizontal position, and a corresponding rear pivot member resting on the rear upright lattice structure.

By comparing FIG. **5** with FIG. **4**, the operation of the seed tank support mechanism can be understood. When the left wing gauge wheel **26** encounters a depression or lower contour, the wing section rotates clockwise relative to the hinge **44** between the left wing frame section and the center frame section, as seen in FIG. **5**. The intermediate pivot support member **83** remains in contact with and rests upon the bracket **77** mounted to the forward upright lattice framework **39** of the center section frame. This causes the seed tank to rotate about the pivot or fulcrum member **83** which is permitted to roll slightly to accommodate the motion of the seed tank seen in FIG. **5**. The inboard pivot member **78** raises slightly off the upright lattice framework of the center section; and the seed tank **36** rotates clockwise slightly about the pivot member **83**, acting as a rolling fulcrum.

It will be observed that the distance between the bottom of the seed tank **36** and the horizontal plane of the forward and rear toolbars of the left frame section **24** remains substantially constant in FIG. **5**, and that there is comparatively little lifting even of the inboard end of the seed tank relative to the frame of the center section. It will also be observed, as will be further described below, that in this position, the seed tank continues to feed seed to the three front row units mounted to the front toolbar of the left wing section, these row units are designated **88***a*, **88***b* and **88***c* in FIG. **5**, as well as to the front row units mounted to the front toolbar of the center frame section, the two row units on the left side being designated respectively **89***a* and **89***b* in FIG. **5**.

Persons skilled in the art will readily be able to substitute other structures for these pivot members which permit the inboard end of the seed storage tanks to rotate and more laterally simultaneously while supporting the seed tanks in order to accommodate the motion described under various use conditions encountered.

During the upward motion of the outboard end of the wing section illustrated in FIG. **6**, the upright link **71** connecting the metal support of the seed tank **36** with the outboard side of the upright forward lattice framework **31** of the left wing section remains generally upright and continues to support the weight of the seed tank, together with the corresponding upright link on the rear of the seed tank, and the two aligned pivot support members or stops, such as the one designated **83** on the metal support **59**.

Turning now to a comparison of FIG. **6** with FIG. **4**, the operation of the seed tank support structure will be described with reference to the wing gauge wheel **26** riding over an elevated section of land, as represented in FIG. **6**. In this case, the wing section rotates counterclockwise about the pivot **44**, the upright link **71** rotates slightly clockwise about the lower pivot **72**, elevating the outboard end of the seed tank **36** slightly, and employing the inboard pivot member **75** as a support bearing or rolling fulcrum to support the inboard end of the seed tank and permit the tank to rotate counterclockwise slightly. The intermediate pivot member **83** and its corresponding rear pivot member are raised above the upright lattice framework of the center section. It will be observed that the variations in height between the bottom of the seed tank and the toolbars of the wing section and center frame section are increased slightly in the region above the hinge pivot **44**, but this distance is otherwise substantially the same, and even that height variation does not unduly stress the flexible hoses feeding seed from the upper portion of the seed tank to the row units, as will be better understood from subsequent description.

Returning now to FIG. **2**, individual planter row units such as the one designated generally by reference numeral **92** are mounted in laterally spaced relation, as is known in the art, to the front toolbar **27** of the left wing section **24**, and similar row units such as the one generally designated **94** in FIG. **2** are mounted to the rear toolbar **28**. Row units are similarly mounted along the front and rear toolbars of the center section and the right wing section. The row units **92** mounted in front of toolbar **27** are referred to as "push" units and the row units **94** are pulled by the rear toolbar **28**. Each of the row units **92**, **94** is otherwise similar in its overall structure and function. A four-bar linkage generally designated **96** is mounted to the rear of the frame of push-type row unit **92** and to the front toolbar, and a similar four bar linkage **97** is mounted to the rear toolbar **28** and to the front of the frame of the pull-type row unit **94**.

Turning then to the row unit **94**, it includes a twin-disc furrow opener **99**, a pair of depth gauge wheels, one of which is shown at **98**, and a rear furrow-closing device generally designated **100**, all of which are conventionally mounted to a row unit frame **101** to which the four-bar linkage **97** is mounted. Above the frame **101** there is mounted a tank **103** which is covered by a lid **104**. The tank **103** is sometimes referred to as a "mini" tank or a buffer hopper. It has a substantially smaller storage capacity than the conventional seed hopper of a conventional planter row unit. Otherwise, to persons skilled in the art, the opener **99**, gauge wheels **98** and closure arrangement **100** are known in the art. The push-type row unit **92** may be similar and need not be described in further detail. Moreover, the present invention may be adapted to grain drills, as well, using conventional furrow openers, depth gauge wheels and closers. In such cases the planting unit need not have the meter or buffer tank mounted to the ground-engaging tools. As used herein, the term "planting unit" is intended to broadly refer to all such devices as well as any other planting ground-engaging devices for opening and closing seed furrows.

Using the present invention, a grain drill could be constructed with the seed meters located at a high point in the tank, above the bottom. The lift augers would bring the seed up to the meters and evenly distribute the seed to all openers. The delivery hoses would extend to the openers form a position along the bottom of the seed tank, and have enough length to flex with the movement of the opener device. Draining the system to change seed varieties or type could be done with the floor auger. The over-all machine height could be lowered and the function of the machine improved.

Referring now to FIG. **3**, the push-type row units **92** are seen to be spaced at equal increments, as are the pull-type row units **94**. The push-type row units are located midway between the two pull-type row units located to the rear so that the lateral spacing between each row unit is the same across the width of the entire planter. As is known in the art, when it is desired to plant corn, typically only the rear row units **94** are used, and a typical row spacing for corn may be thirty inches between adjacent rows. When it is desired to plant soybeans, both the forward row units **92** and the rearward row units **94** are used to plant, so that the spacing between adjacent rows for soybeans is fifteen inches.

Returning, then, to FIG. **2**, seed is fed under gravity from the seed storage tank **36** by means of a flexible hose **105** connected to the seed box overhangs to the rear or pull-type row unit **94**, and by means of a second flexible hose **106** to the front push-type row unit **92**. It will be observed from FIG. **2** that the vertical drop in the hoses **105**, **106** is substantial and this is considered an important feature

because it permits the seed to be fed from the storage tank to the individual row units under gravity (i.e., without additional conveying mechanism). Moreover, in order to accommodate the independent vertical motion of the individual row units (permitted by the four bar linkages mounting the row units to their associated toolbars and the hinged connection between the center section and wing section frames), the hoses **105**, **106** are flexible so that they may extend or compress as well as move laterally. It will be observed that the seed inputs to the forward row units are spaced approximately the same distance from the associated seed outlet of the seed storage tank as the seed inlet of the rear row unit is spaced from its associated seed outlet of the seed storage tank. This symmetry is further considered important for reasons which will be apparent, but including the fact that the travel distances for seed for both forward and rear delivery tubes **105**, **106** are approximately equal, yet both conduits permit independent vertical motion of their associated planter row units.

Turning now to FIG. **14**, the interior of an individual seed storage tank is seen. The view of FIG. **14** can be considered to be a vertical cross section of the left side tank **36**, as viewed from the front, or it may be considered to be a vertical rear view of the right side of the storage tank **55** since they are mirror images of one another. For purposes of description, it will be assumed that the view of FIG. **14** is a front view of the left seed storage tank **36**. Located at the bottom of the storage tank is an elongated floor auger **107** which extends substantially the entire length of the storage tank. The auger **107** may be a brush auger—that is, the auger flight is made of bristles, not metal or other solid material in order to reduce breakage or chipping of the seed. Alternative forms of conveyors may also be used, as persons skilled in the art will appreciate. The lower portion or wall of the seed storage tank has a uniform radius as at **108** in FIG. **11**, and this radius conforms to the radius of the periphery of the flights of the auger **107** so that the seed storage tank may be substantially clean when it is run out of seed, and otherwise promote efficient movement of the seed within the storage tank. Moreover, adjacent the lower radiused portion **108**, the bottom wall of the storage tank is sloped inwardly, both front and rear, to further assist in the delivery of seed to the auger under gravity.

Above the floor auger **107** is a plate **109** which also is curved similar to the radius at **108** to promote efficient conveyance of the seed. However, the edges of the top wall **109** are spaced from the sloped front and rear walls **108***a* of the bottom wall to permit seed to fall between the sloped walls **108***a* and the edges of plate **109** as the auger empties. As persons skilled in the art know, an auger of this type will draw substantially all of the seed at the input end (to the left in FIG. **14**) as long as there is seed in the tank covering the auger and the speed of the auger is proper.

The lower feed auger **109** delivers seed to an elevator auger **112** which is housed within a tube **113**, and is inclined upwardly and toward the center of the seed tank at a inclination of approximately fifteen degrees above the horizontal. The elevator auger **112** delivers seed to a second elevator auger designated **114** housed within a tube **115**. The auger **114** delivers seed upwardly into the right to the input of a fourth or distribution auger conveyor **118** which is housed within a distribution manifold **120**. The distribution manifold **120** extends horizontally across the upper portion of the seed storage tank **36** toward the center of the planter.

Spaced along the length of the distribution manifold **120** are a series of discharge manifolds, including forwardly inclined discharge manifolds generally designated **123** and rearwardly inclined discharge manifolds such as those designated **124**. The forward discharge manifolds **123**, as best seen in FIG. **11**, extend downwardly and forwardly to discharge seed into the forward flexible hoses **106**, and the rear discharge manifolds **124** extend downwardly and rearwardly to feed seed into the rear flexible tubular conduits **105** feeding the rear row units **94**.

Referring now to FIG. **12**, each of the discharge manifolds **123**, **124** are similar, thus, only one needs to be described in further detail. The discharge manifold **123** includes an upper section **126** and a lower section **127** which have mating flanges for assembling them together by conventional fasteners. The upper and lower sections **126**, **127** fit around and seal with the cylindrical distribution manifold **120**, but the distribution manifold may be rotated within the discharge manifolds **124**, as will be described. The lower, discharge portions of the discharge manifold **123** come together to form a tubular collar **128** which is provided with a steel nipple **129** to which an associated conduit **105** or **106** is attached by means of a conventional hose clamp. It will be observed from FIG. **2**, for example, that the lid **104** of the buffer hopper **103** of the rear row unit **94** is also provided with a forwardly extending nipple **131** to which the bottom end of the hose **105** is attached. The lid **104** is further provided with a rear nipple **132**, which may be closed with a transparent cover so that the interior of the hopper may be viewed if desired. As can be seen in FIG. **2**, the lid of the buffer hopper of the forward rear unit **92** is similar in structure to the lid **104**, having a forward nipple **131***a* and a rear nipple **132***a*. However, in this case, the discharge hose **106** is fitted to the rear nipple **132***a*, and the forward nipple **131***a* is provided with a transparent closure for inspection purposes.

Turning now to FIG. **15**, the distribution manifold **120** has formed in it, along one longitudinal line parallel to the axis of rotation of the auger, a series of discharge openings **130** which are spaced at approximately fifteen inch intervals and which supply both front and rear row units. On the diagonally opposite side of the cylindrical discharge manifold **120**, that is, along a line also parallel to the axis of rotation of the auger, are a series of discharge openings such that at designated **131** which are spaced at thirty inch intervals and which are designed to supply only the discharge manifolds associated with the rear row units. The ends of the distribution manifold **120** are received in cylindrical cup-shaped receptacles or bushings designated **133** in FIG. **14**. The bushings **133** are mounted to the respective end walls, **135**, **136** of the seed tank, and they support the distribution manifold **120**. The distribution manifold **120** may be thus rotated between the position shown in FIG. **15**, wherein seed is provided only to the rearwardly extending discharge manifolds **123**, and the position of FIG. **16** wherein the more closely spaced apertures **130** are aligned with the discharge manifolds so that both front and rear end units are provided with seed continuously.

Still referring to FIG. **14**, an inclined isolation baffle **138** extends from an upper overflow opening **139** at the discharge end of the distribution manifold, downwardly and inwardly to join with the left end of the cover plate **109** of the floor auger **107**. The baffle **138**, together with the end wall **135** and side and bottom walls of the tank form a transition region **141**, the purpose of which will be described presently. Similarly, an incline wall or baffle **142** cooperates with the end wall **136** and the forward and rear walls and bottom of the storage tank **36** to form a second transition region **144**.

Turning now to the drive for the augers within the seed storage tank, a hydraulic motor **145** is mounted to the inner

wall **135** of the storage tank **36**, and it drives the shaft of the distribution auger **118** directly. The shaft of the distribution auger **118** extends through the outboard sidewall **136** into an upper gear box **146** which includes an output spur gear driving a U-joint **147** coupled to the shaft of the upper elevator auger **114**.

The shaft of the distribution auger **118** extends through the gear box **146** and drives a sprocket **149** which, in turn, drives a lower sprocket **150** by means of a chain **151**. The sprocket **150** is mounted on the shaft of the floor auger **107** which extends through a lower gear box **153**. An output spur gear of the gear box **153** drives the lower elevator auger **112** by means of a U-joint **154**.

In operation, when all of the augers are driven as just described, seed within the storage tank is fed to the left end of the floor auger **107**. Originally, the seed falls in the spaces to either side of the cover plate **109** and enters the auger at the left side just inside of the inclined baffle **138**. Eventually, the floor auger fills with seed and seed is delivered into the transition region **144** where it is then feed into the first elevator auger **112**. The first elevator auger **112** delivers seed to an aperture in the tube **113** which is aligned with a corresponding aperture in the tube **115** of the upper elevator auger. Seed is thus fed in the upper elevator auger **114** to the right end (again through a pair of communicating, aligned openings in tubes **115, 120**) into the distribution manifold where it is conveyed to the discharge manifolds **123, 124** from right to left. Each discharge manifold feeds its associated flexible conduit and buffer hopper or planting device. When one becomes full, the seed is then communicated to the next discharge manifold for which one of the discharge openings **130, 131**, as described above, is aligned. When all of the discharge manifolds, connecting conduit and buffer hoppers are full, seed is conveyed to the left end of the discharge manifold **120** where it is deposited through the overflow aperture under gravity to the left end of the floor auger **107**. The transition **141** isolates this overflow seed from the main body of seed in the remainder of the storage tank, the overflow seed being fed directly to the input of the floor auger **107**.

Thus, the seed continues to be re-circulated; and as seed is planted, it is replenished immediately. This recirculating distribution system obviates the need for measuring the flow of seed in a distribution system for each seed tank because seed in the associated floor auger is immediately replenished as long as there is seed in the storage tank. Moreover, as mentioned, the floor auger feeds seed from the input end as long as it is surrounded by seed. As the supply of seed diminishes within the main storage area of the tank **36** (that is inboard to outboard), the remainder of the seed will be in the outboard area of the storage tank and be fed around the sides of plate **109**. This adds ballast to the wing sections where ballast is better applied. In other words, there is already sufficient weight on the center section due to the weight of the axle assembly and the lift mechanism as well as the weight of the tongue. However, when the planter is used in hard-packed ground, additional weight on the wing sections is useful to facilitate forming a furrow.

Turning now to FIG. **17**, there is shown an alternate elevator for raising seed from the floor auger. A first, continuous conveyor belt **200** is entrained about upper and lower rollers **201, 202**. A second continuous conveyor belt **204** is entrained about various rollers, including a take-up reel, and its inner surface is in driving contact with the outer surface of the inner belt **200**. The two belts are in side-by-side adjacent contact between the rollers **202** and **201**, traveling in a vertical direction.

The Lower Feed Auger delivers seed through an aperture at the bottom of the endwall **136** of the seed tank. The seed is deposited onto the inner surface of the outer belt **204** along a horizontal stretch extending beneath the lower feed auger **107**. The seed is conveyed to the nip point between the two conveyor belts **200, 204** which is formed at the bottom of roller **202**. The seed is then moved upwardly, secured between the two belts, with adjacent surfaces in opposing relation, and delivered to the input of the upper conveyor top auger **118** where the inner belt diverges from the outer belt and returns about the upper roller **201**. A trough **208** is carried by the end wall of the hopper. Trough **208** has a curved portion below the input end of the upper distribution auger **118** to catch and hold seed from the belt elevator to feed auger **118**, and a vertical wall **209** to the left of auger **118** to assist in delivering seed to the auger. The outer belt is driven by roller **206**, and it, in turn drives the inner belt. Roller **206** is driven by a conventional hydraulic motor. Belt **204** is pinched between drive roller **206** and idler **210**. A spring loaded belt tensioning device **207** is included to maintain proper tension on drive belt **204**.

Having thus disclosed in detail an illustrated embodiment of the invention, persons skilled in the art will be able to modify certain of the structure which has been disclosed and substitute equivalent elements for those depicted while continuing to practice the principle of the invention. It is, therefore, intended that all such modifications and substitutions be covered as they are embraced within the spirit and scope of the appended claims.

What is claimed is:

1. Seed distribution apparatus for an agricultural planting machine having an elongated frame extending transverse of a direction of travel, comprising:

a plurality of seeding units mounted in spaced relation along said frame;

an elongated seed storage tank mounted above said frame and extending laterally of said frame;

a distribution conveyor at an upper portion of said tank and extending longitudinally of said tank;

an elevator feeding seed from the bottom of said tank to said distribution conveyor; and

a flexible conduit for each of said seeding units routing seed under gravity from said distribution conveyor to an associated seeding unit.

2. The apparatus of claim **1** wherein said distribution conveyor comprises an elongated tubular distribution manifold extending longitudinally of said tank substantially the entire length thereof and a conveying mechanism within said distribution manifold for transporting seed longitudinally of said distribution manifold, each of said flexible conduits being coupled to receive seed from said distribution manifold at a different lateral spacing along said distribution manifold, said distribution manifold having a seed input end and a seed outlet end, excess seed not delivered to said flexible conduits being expelled from said outlet end of said distribution manifold and returned to a store of seed within said tank.

3. The apparatus of claim **2** further including a discharge manifold associated with each of said seeding units coupled to said distribution manifold at one end and coupled to an associated one of said flexible conduits at another end; said distribution manifold being a cylindrical tube.

4. The apparatus of claim **3** wherein said seeding units are planter row units, each row unit including a buffer hopper coupled to an associated flexible conduit; and wherein said apparatus includes a first plurality of said row units mounted

to the front of said frame to be pushed by said frame and a second plurality of row units mounted to the rear of said frame to be pulled by said frame in use, and wherein said flexible conduits include a first plurality of flexible conduits coupled to said distribution manifold for feeding rear-mounted row units and a second plurality of conduits for feeding forward-mounted row units; and wherein said distribution manifold is mounted for rotation about an axis and within said discharge manifolds, said distribution manifold including a first plurality of openings communicating only with said first plurality of flexible conduits when said distribution manifold is rotated to a first position, and a second plurality of openings communicating with said first and second pluralities of flexible conduits when said distribution manifold is rotated to a second position.

5. The apparatus of claim 3 wherein said seeding units includes a first plurality of seeding units mounted to the front of said frame to be pushed by said frame; and

a second plurality of seeding units mounted to the rear of said frame to be pulled by said frame in use, wherein said flexible conduits include a first plurality of flexible conduits coupled to supply seed to said first plurality of seeding units, and a second plurality of flexible conduits coupled to provide seed to said second plurality of seeding units.

6. The apparatus of claim 5 wherein said tubular member of said distribution manifold is rotatably mounted within said tank, said tubular member including a first plurality of apertures for feeding seed from said distribution manifold to both said first plurality of seeding units and said second plurality of rear-mounted seeding units, and wherein said tubular distribution manifold includes a second plurality of apertures for feeding seed only to one of said first plurality of seeding units and said second plurality of seeding units, whereby said tubular distribution manifold may be rotated between a first position to provide seed to said forward-mounted and said rear-mounted seeding units, and a second position to provide seed to only one of said plurality of seeding units.

7. The apparatus of claim 5 wherein said tubular manifold comprises a cylindrical wall rotatable about an axis and having openings adapted to communicate respectively with associated ones of said discharge conduits, whereby when said wall is rotated to a first position, the openings thereof align with associated discharge conduits to permit seed to flow under gravity to associated seeding units, and when said tubular member is rotated to a second position, said cylindrical wall thereof aligns with associated discharge conduits to prevent seed from flowing from said tubular member to said predetermined discharge conduits, thereby permitting an operator to selectively inhibit individual planting units from receiving seed from said tank.

8. The apparatus of claim 2 further including a second conveyor located below said distribution conveyor conveying seed within the bottom of said tank to one end thereof;

an elevator for moving seed from said second conveyor upwardly to said distribution conveyor, whereby seed is recirculated through said tank and all of said discharge manifolds in the open position receive seed from said distribution manifold as long as seed is available within said tank.

9. The apparatus of claim 1 wherein said elongated seed tank comprises a unitary tank having an open top for loading seed into said tank;

a cover for covering said opening; and

characterized in that said tank extends from an outboard end of said planter frame substantially to the center of said planter frame.

10. The apparatus of claim 9 wherein said tank further comprises a metal band supporting upright walls of said tank and coupled to said frame for support.

11. The apparatus of claim 1 wherein said frame comprises;

a center section frame supported by wheels;

a first wing section frame hinged to a first outboard end of said center section frame;

a second wing section frame hinged to a second outboard end of said center section frame;

wherein named seed tank extends from a position approximately at the middle of said center section frame continuously to a position adjacent said outboard end of said first wing section frame; and

further comprising a second elongated seed storage tank mounted above said frame and extending laterally from approximately the center of said center section frame to an outboard end of said second wing section frame.

12. In an agricultural planter having an articulated frame including a center section frame and at least one wing section frame hinged to said center section frame for pivotal motion in a vertical direction, the improvement comprising:

an elongated seed tank extending laterally from a location adjacent an outboard end of said wing section frame to a location above said center section frame thereby to extend over and be carried by both said wing section frame and said center section frame;

a first link supporting an outboard end of said tank, said link having a first end pivotally coupled to said tank and a second end pivotally coupled to said wing section frame;

a support member coupled to said tank at an intermediate location and engaging said frame whereby as said wing section lowers to follow ground contour, said tank pivots about said support member such that the outboard end of said tank lowers and the inboard end of said tank rises and is supported by said center section frame.

13. The apparatus of claim 12 further comprising a second link having a first end pivotally coupled to said tank and a second end pivotally coupled to said articulated frame and arranged to limit lateral movement of said tank as it is tilted as its associated wing section raises and lowers to follow ground contour.

14. The apparatus of claim 13 wherein said articulated frame further comprises a second wing section frame hinged to said center section frame, said apparatus further comprising:

a second elongated seed tank extending laterally from a location adjacent an outboard end of said second wing section frame to a location above said center section frame;

a third link supporting an outboard end of said second tank, said third link having a first end pivotally coupled to said second tank and a second end pivotally coupled to said second wing section frame;

a fourth link having a first end pivotally coupled to said tank and a second end pivotally coupled to said articulated frame to resist lateral motion of said second tank; and

a second support member coupled to said second tank and engaging one of said center section frame and second wing section frame.

15. The apparatus of claim 12 further comprising a second support member coupled to said first tank at a location

outboard of said first support member, said first and second support members constructed and arranged such that when said first wing section frame rotates downwardly relative to said center section frame to follow ground contour, said first named tank is supported by said first support member, and when said first wing section frame is elevated in response to a higher ground contour than said center section frame, an inboard end of said first named tank is supported by said second support member.

16. The apparatus of claim 12 wherein said wing section frame comprises a right wing section frame hinged to said center section frame for pivotal motion in a vertical direction;

and said apparatus further includes a left wing section frame hinged to said center section frame for independent pivotal motion in a vertical direction;

a second seed tank carried by said left wing section frame and said center section frame; and

each of said seed tanks extending from a location adjacent respective outboard ends of said left and right wing section frames to respective locations adjacent the center of said center section frame, whereby each seed tank straddles its associated hinge connection to said center section frame, each tank being pivotally supported at an outboard end to its associated wing section and pivotally supported at an intermediate location adjacent the center of said center frame section.

17. The apparatus of claim 12 wherein the pivotal support of the inboard end of said tank comprises a cylindrical pivot member resting on said center section frame when said wing section frame is level, said apparatus further including a second link pivotally connected at an inboard and to said tank and at an outboard end to said wing section frame, said second link being located in a generally horizontal disposition to resist lateral movement of said tank as the outboard end of the associated tank raises and lowers in response to changing ground contour.

18. The apparatus of claim 12 wherein said support member is a pivot member engaging said center section frame when said wing section frame is lowered relative to said center section frame.

19. An agricultural seed planter comprising an elongated frame extending transverse of the direction of travel;

a first plurality of seeding units mounted behind said frame in laterally spaced relation for independent vertical movement in a response to ground contour charges;

a second plurality of seeding units mounted in front of said frame in laterally spaced relation for independent vertical movement;

an elongated seed tank carried by said frame and having an elongated upper opening to receive seed in bulk form;

a distribution manifold within said tank and extending therealong;

a conveyor moving seed from within said tank through said distribution manifold;

a first plurality of flexible conduits, each conduit of said first plurality coupled to said distribution manifold at one end to receive seed and coupled to an associated one of said first plurality of seeding units at another end to deliver seed to said first plurality of seeding units; and

a second plurality of flexible conduits, each conduit of said second plurality coupled to said distribution manifold at one end to receive seed and coupled to an associated one of said second plurality of seeding units at another end to deliver seed to said second plurality of seeding units.

20. In an agricultural planter, the combination comprising:

a frame;

a plurality of seeding units spaced laterally along said frame;

an elongated seed storage tank carried by said frame and having first and second ends spaced apart transverse of a direction of travel for said planter;

a first conveyor at a base of said tank conveying seed along a first lateral direction;

elevator receiving seed from said first conveyor and elevating seed to an upper portion of said tank;

a second conveyor in the upper portion of said tank receiving seed from said elevator and conveying seed along a second lateral direction opposite said first lateral direction; and

a plurality of flexible conduits spaced along said second conveyor, each conduit communicating seed from said second conveyor under gravity to an associated seeding unit.

21. Apparatus for distributing seed in an agricultural planter comprising: a frame extending transverse of a direction of travel of said planter;

a first plurality of ground-engaging seeding units mounted in front of said frame to be pushed in field operation;

a second plurality of ground-engaging seeding units mounted behind said frame to be pulled in field operation;

at least one seed storage tank carried by said frame and extending longitudinally thereof;

a first plurality of flexible conduits, each coupling seed under gravity from said tank to one of said planting units mounted in front of said frame;

a second plurality of flexible conduits, each coupling seed under gravity from said tank to one of said planting units mounted behind said frame; and

a conveyor moving seed laterally within said tank to supply seed to each of said flexible conduits.

22. The apparatus of claim 21 wherein said seed storage tank includes a lower depending portion and an upper extending portion providing an overhang, said flexible conduits having an upper end coupled to said overhang to receive seed therefrom whereby the length of said flexible conduits is sufficient to permit seed meters to be mounted adjacent said overhang or to said seeding units.

23. In an agricultural planter having a frame, and a plurality of planter row units mounted to said frame, said frame including forward and rear upright support structures;

a seed storage tank characterized as having substantially an unobstructed top opening, a lower depending portion received between said forward and rear support structures and carried by said support structures, and an upper overhang portion extending above one of said upright support structures and providing a downwardly facing wall; and

a plurality of flexible conduits extending from said upper overhang portion of said tank downward to associated planter row units to supply seed thereto.

24. The apparatus of claim 23 wherein said seed tank includes an upper distribution conveyor moving seed later-

ally substantially the entire length of said tank; an elevator moving seed from a bottom of said tank up to said distribution conveyor; and a lower conveyor moving seed in the bottom of said tank to said elevator, whereby seed within said tank is circulated within said tank and characterized in that said conduits are supplied with seed from said tank as long as seed remains in the bottom of said tank.

25. The apparatus of claim 24 wherein said tank extends from a lateral end of said from to an inboard location adjacent the center of said frame and characterized in that seed conveyed by said distribution conveyor which is not delivered to said flexible conduits is returned at an outlet end to said tank, said apparatus further including a baffle in said tank located to provide a transition region for seed adjacent an input of said lower conveyor located adjacent an inboard end thereof, whereby seed is first supplied from an inboard end of said tank thereby to maintain seed weight at an outboard end of said tank until the seed supply is exhausted.

* * * * *

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Friggstad

(10) **Patent No.: US 6,305,478 B1**
(45) **Date of Patent: Oct. 23, 2001**

(54) **HYDRAULIC CONTROLS FOR AGRICULTURAL IMPLEMENTS**

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(73) Assignee: **Flexi-Coil Ltd.**, Saskatoon (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/437,864**

(22) Filed: **Nov. 10, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/108,025, filed on Nov. 12, 1998.

(51) **Int. Cl.**[7] **A01B 63/00**
(52) **U.S. Cl.** **172/458**; 172/668; 172/4
(58) **Field of Search** 172/776, 311, 172/458, 668, 464, 4, 452, 487

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Primary Examiner—Robert E. Pezzuto
Assistant Examiner—Nathan Mammen
(74) *Attorney, Agent, or Firm*—Larry W. Miller; John William Stader

(57) **ABSTRACT**

An agricultural implement, having ground engaging tools mounted on subframes that are movable through hydraulic actuators between raised transport and lowered working positions, is provided with a hydraulic circuit in which the actuators are connected in parallel with one another within a grouping of the actuators. The positioning of the ground engaging tools into a lowered working position closes the hydraulic circuit for the group of actuators. The subframes are arranged to float over ground undulations to maintain a common working depth for the ground engaging tools. The vertical movement of any one of the actuators in the common group will force a displacement of a corresponding amount of hydraulic fluid, which will then be shared by all of the remaining actuators in the corresponding group. A depth averaging control for the ground engaging tools and a mechanical headland stop apparatus are also provided for the agricultural implement.

16 Claims, 23 Drawing Sheets

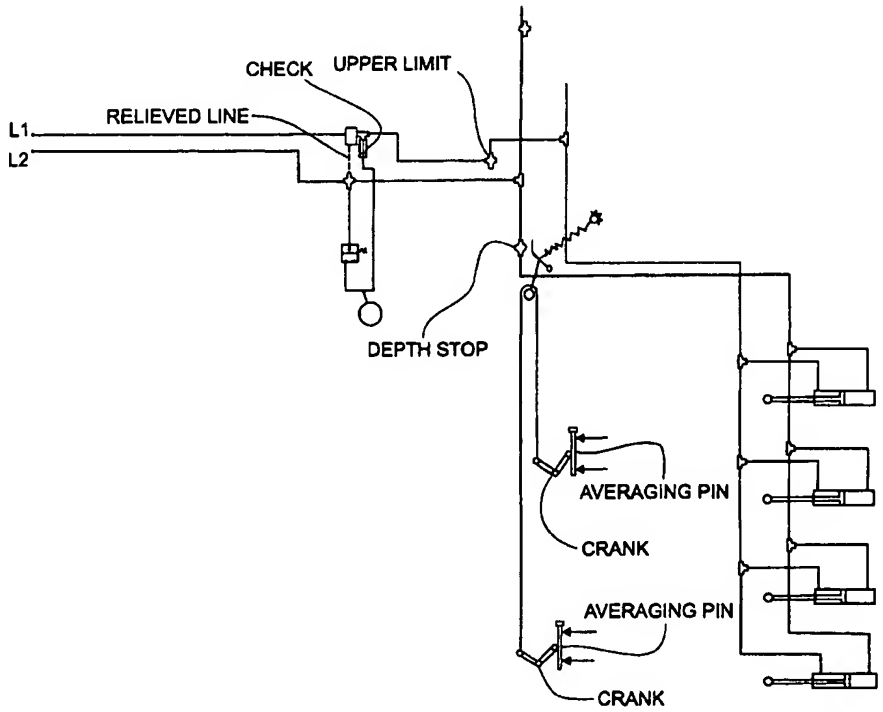

Fig. 1

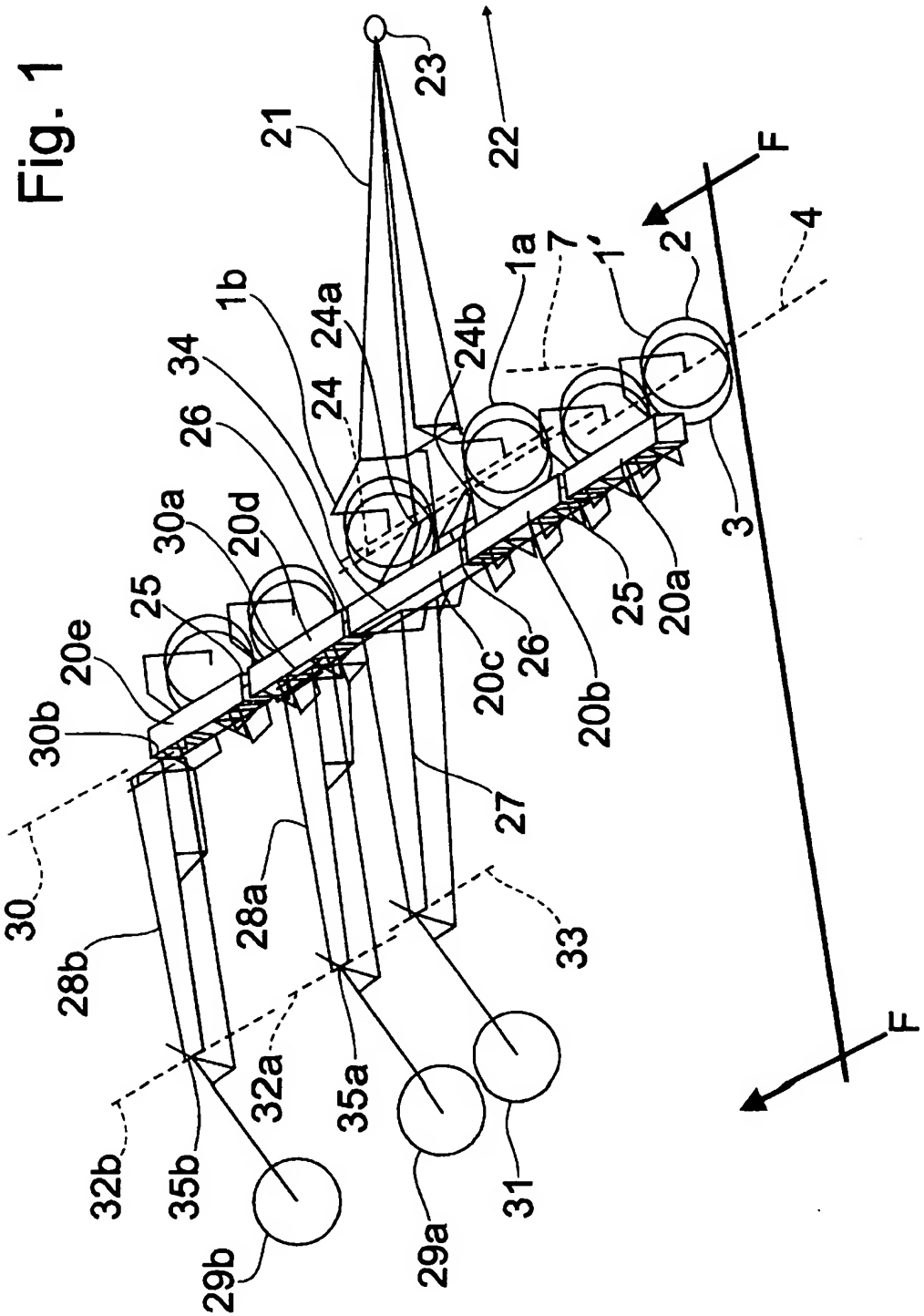
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Fig. 2

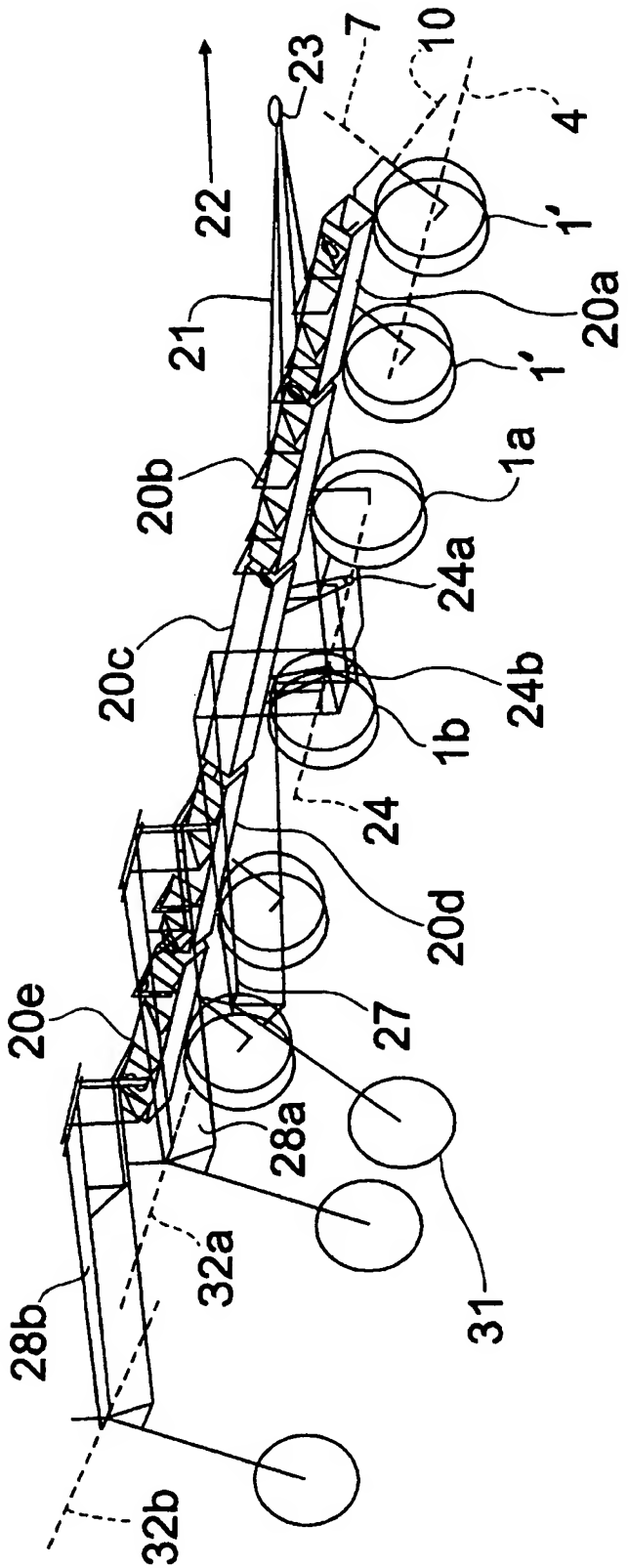
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Fig. 3

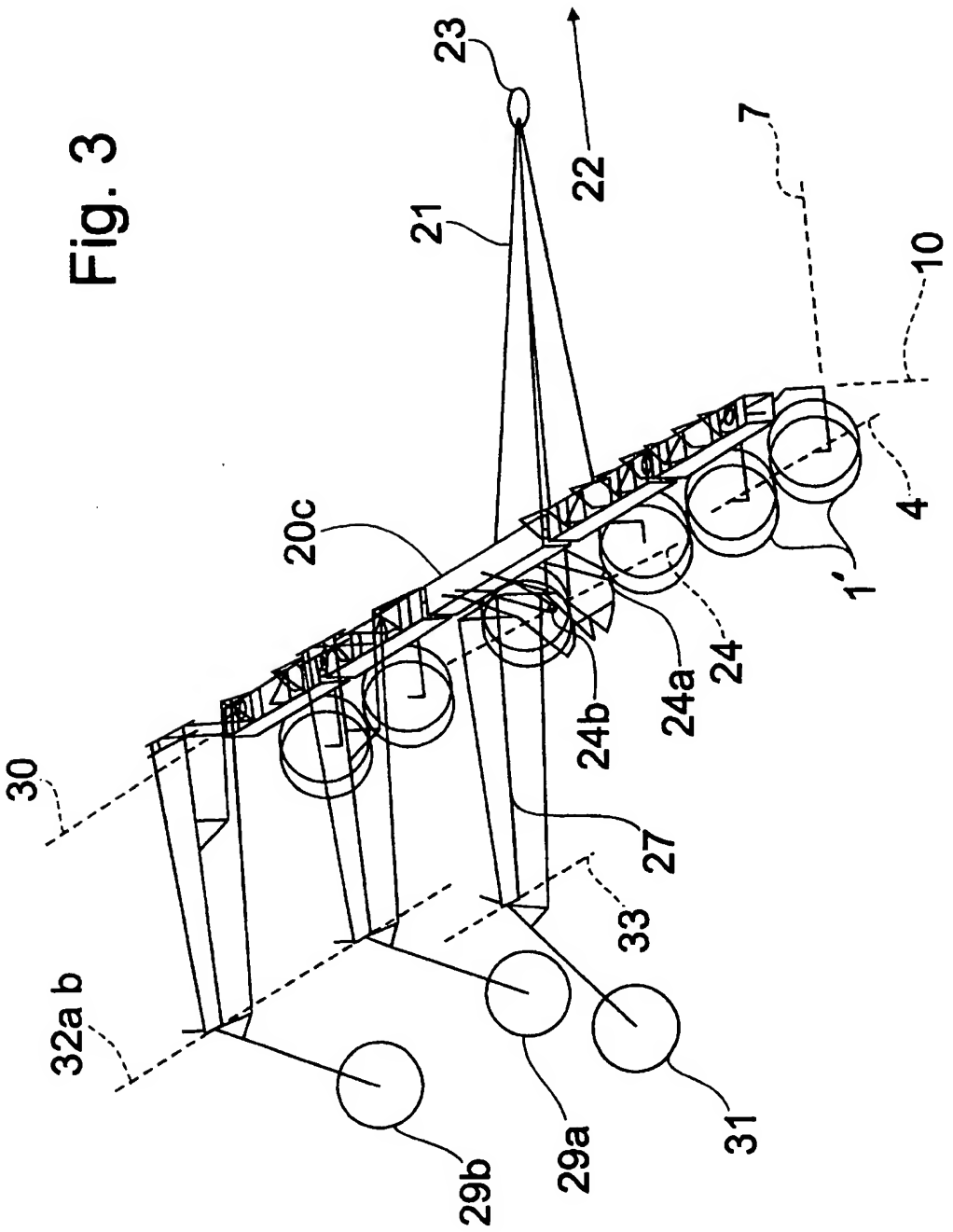


Fig. 4

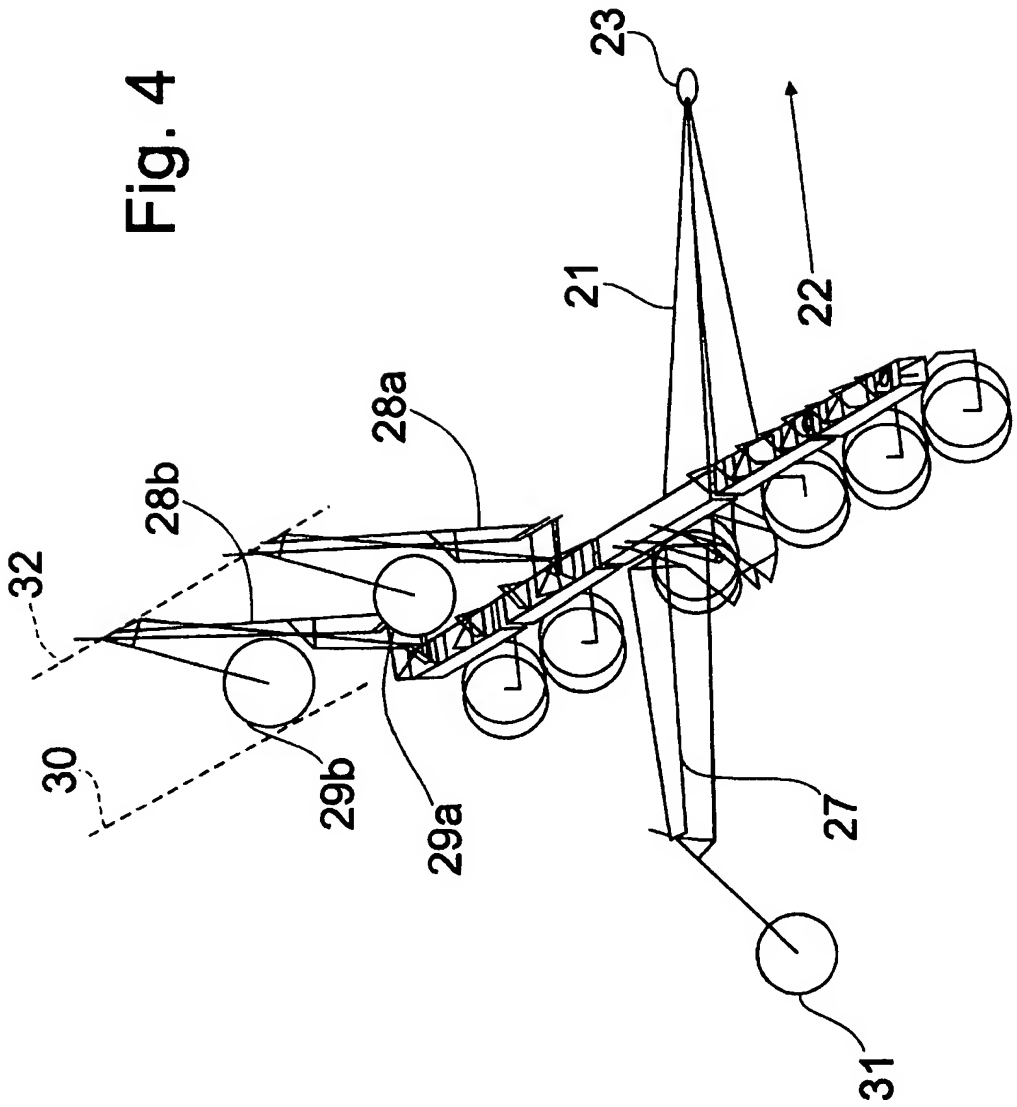
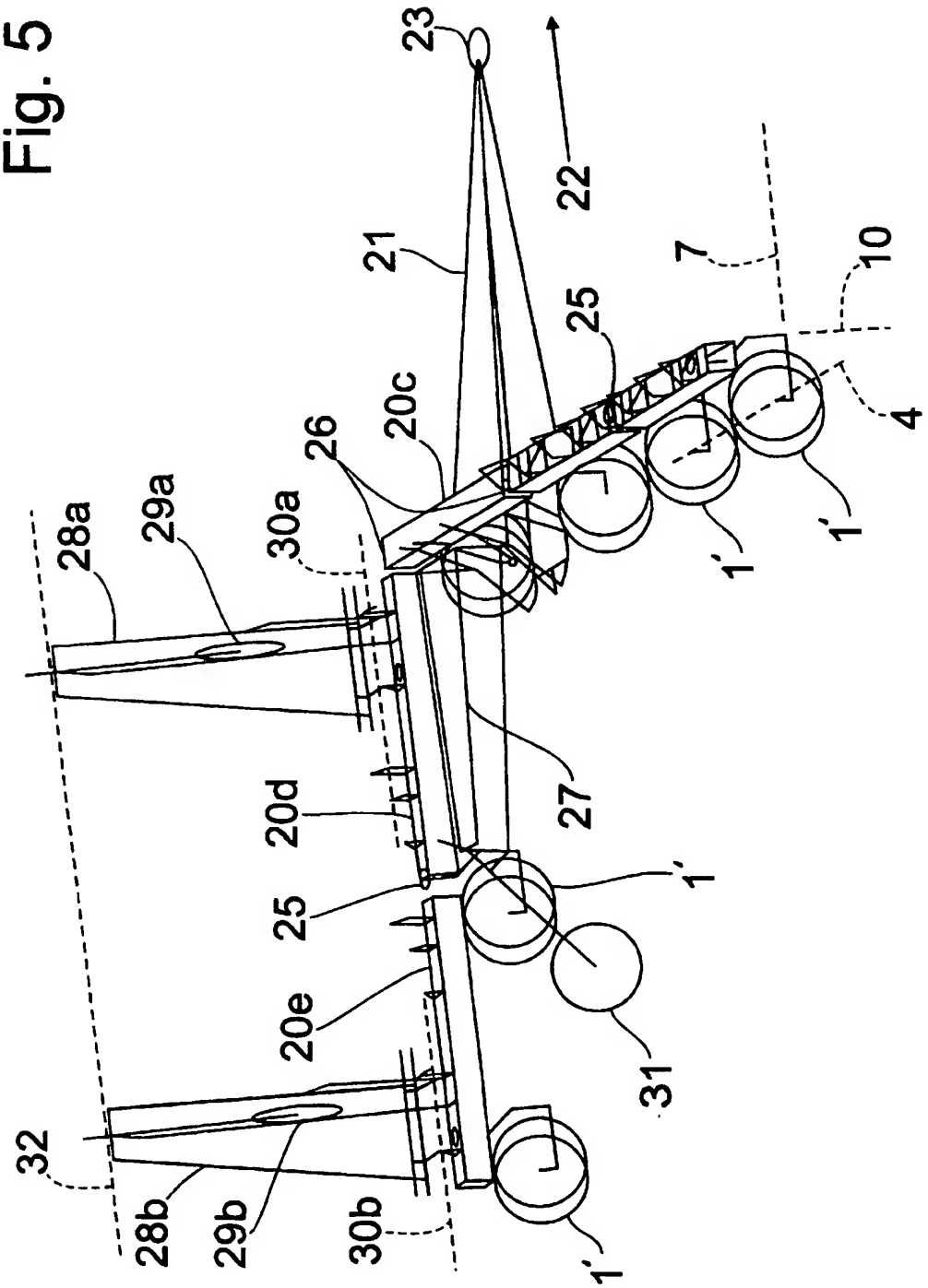


Fig. 5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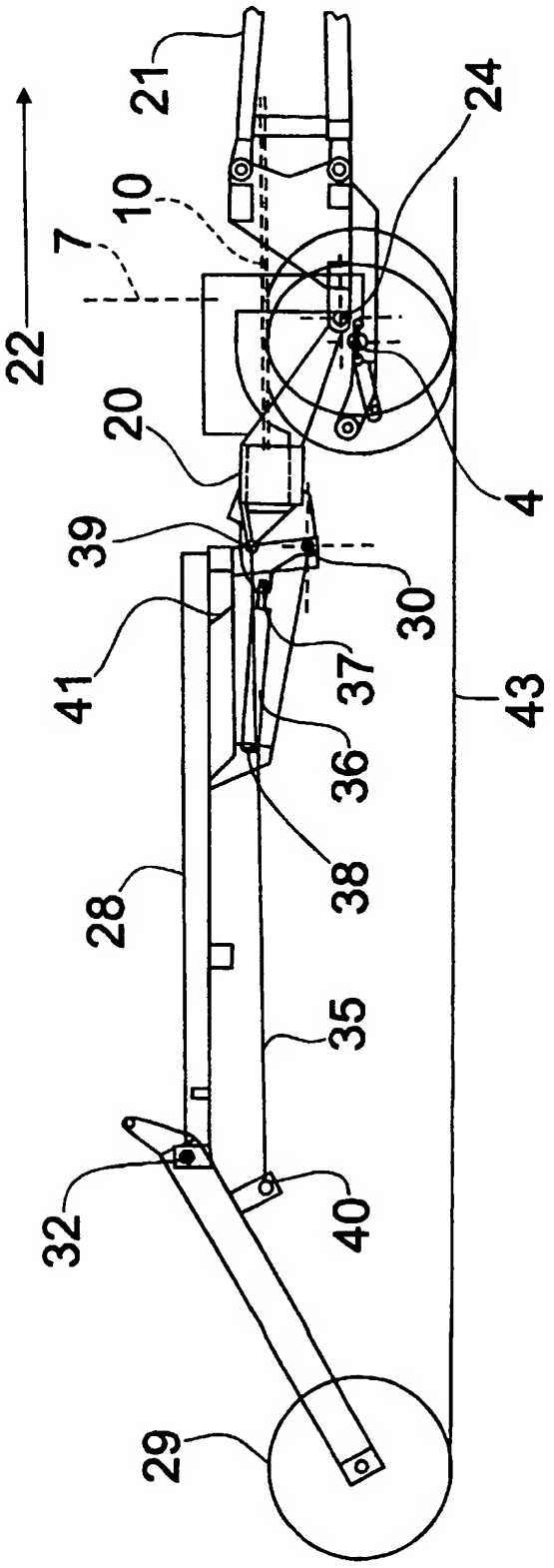


Fig. 6

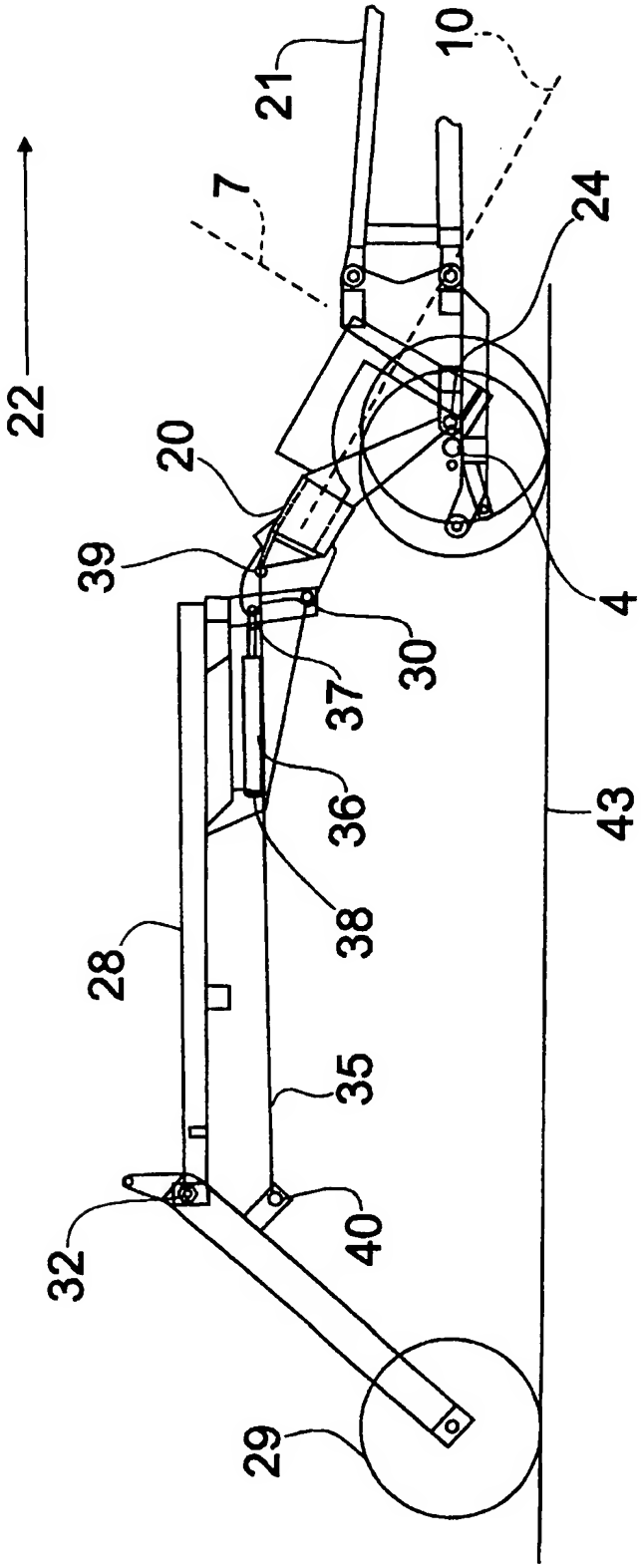


Fig. 7

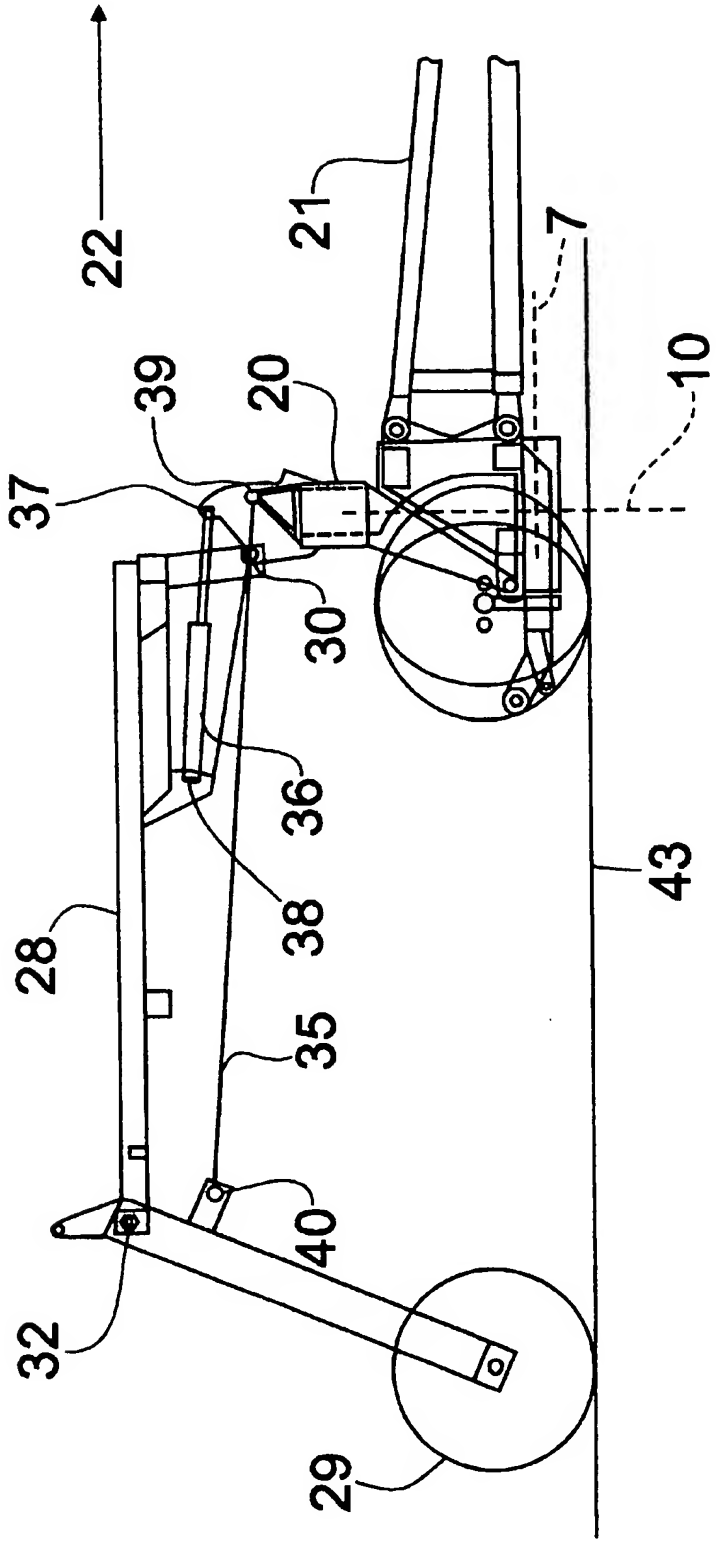


Fig. 8

Fig. 9

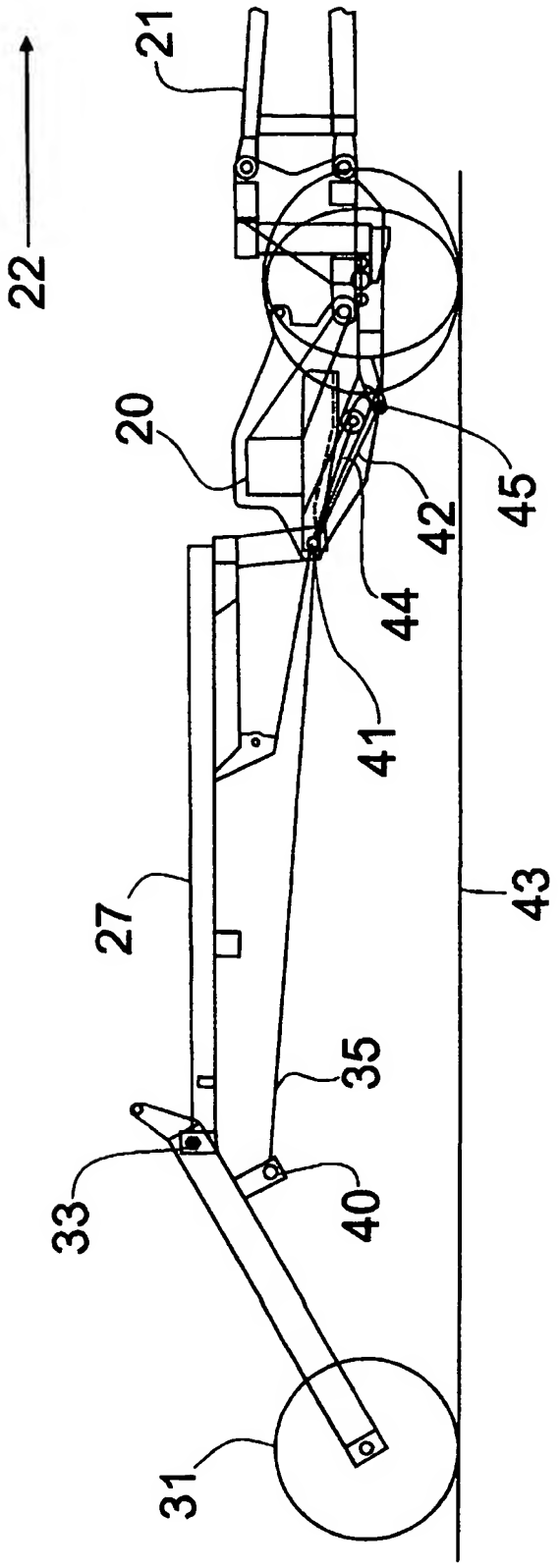


Fig. 10

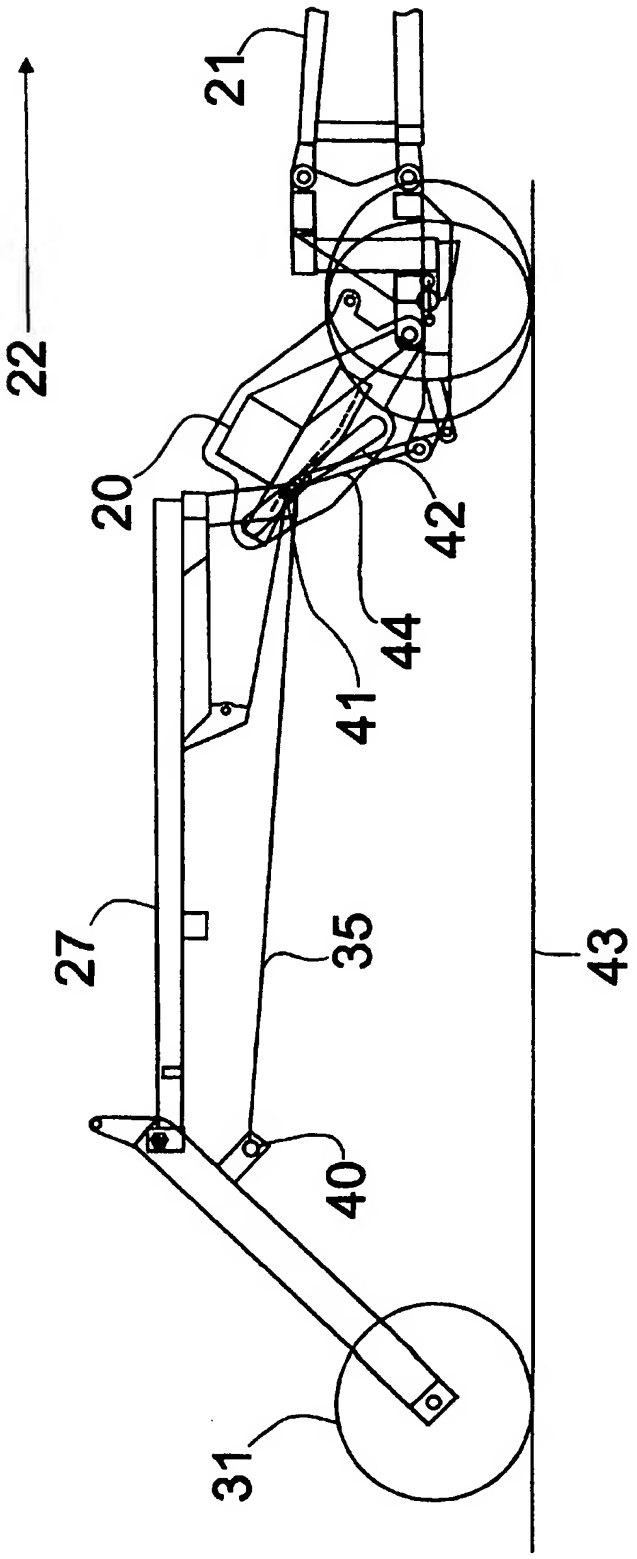
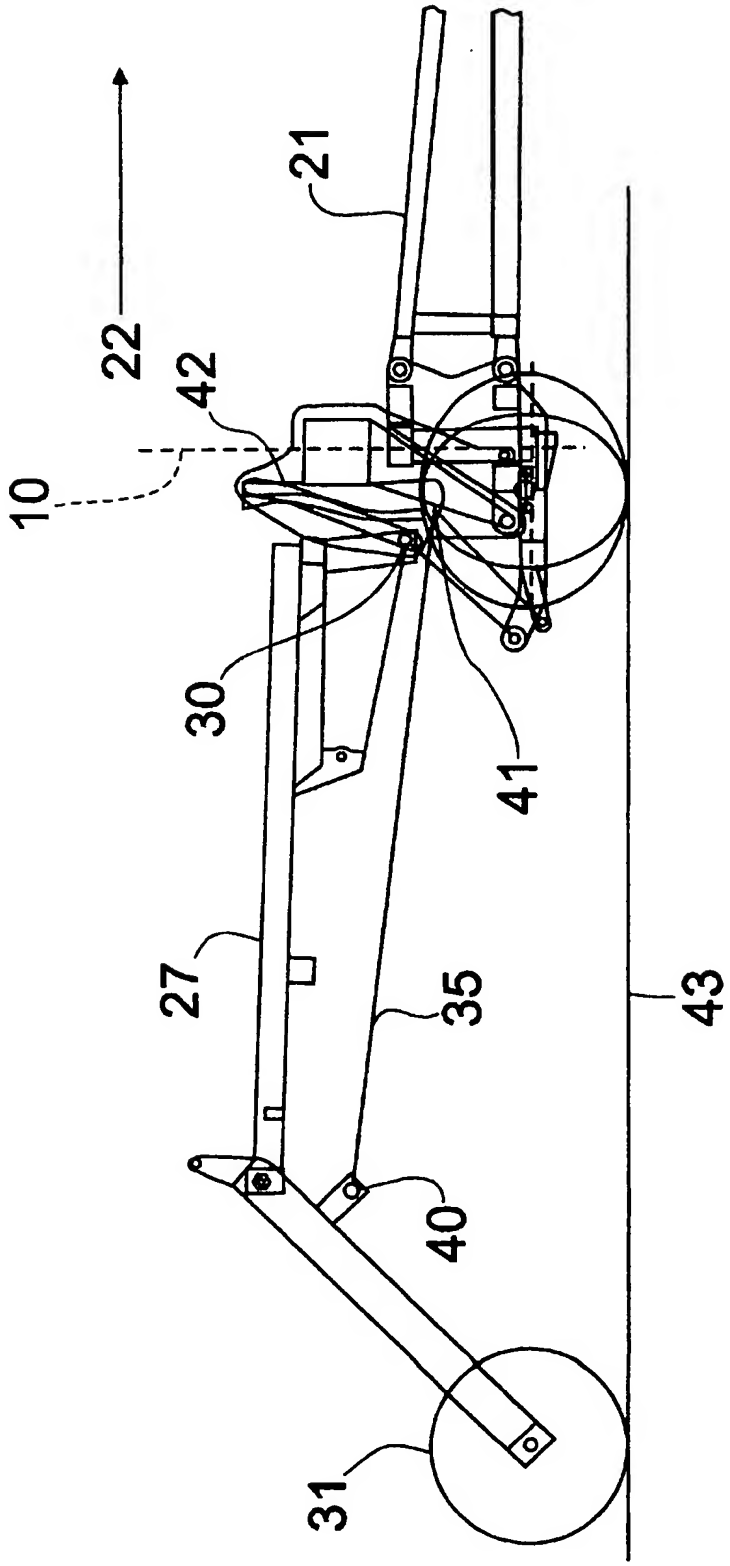


Fig. 11



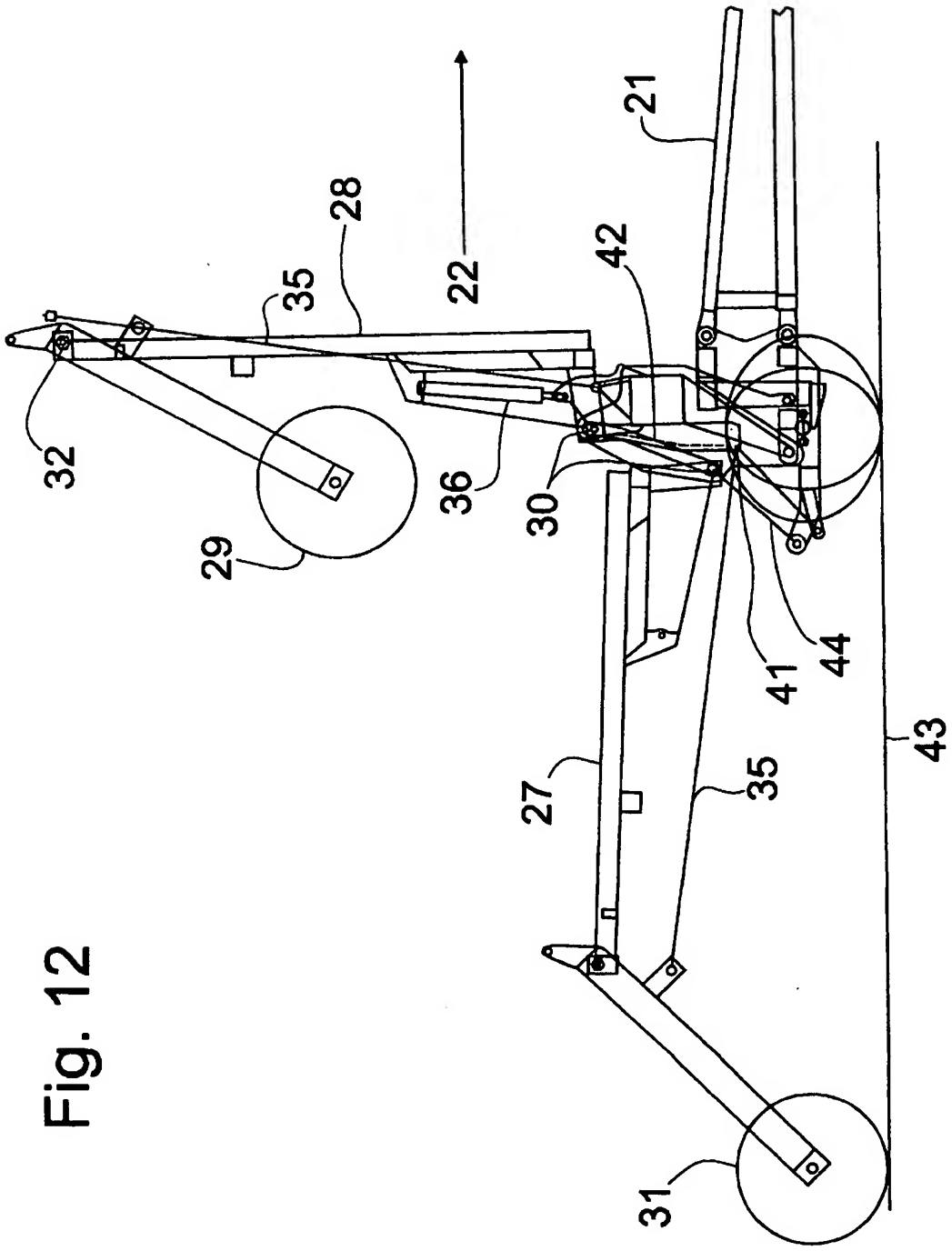
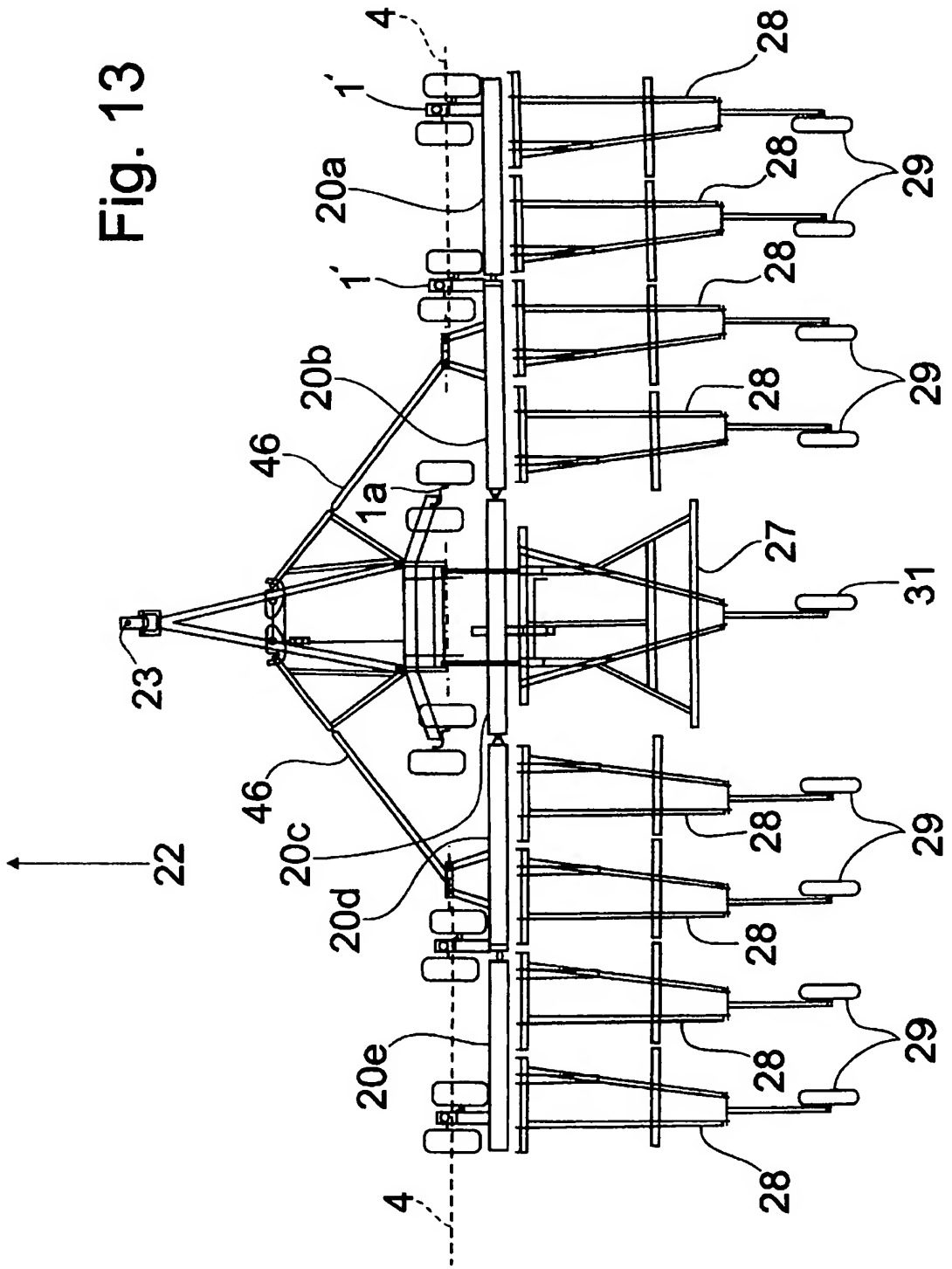


Fig. 12

Fig. 13


4
1'
20a
1'
20b
46
1a
23
46
20c
20d
22
20e
4
28
28
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28
28
29
27
31
28
28
29
28
28
29
28

Fig. 14

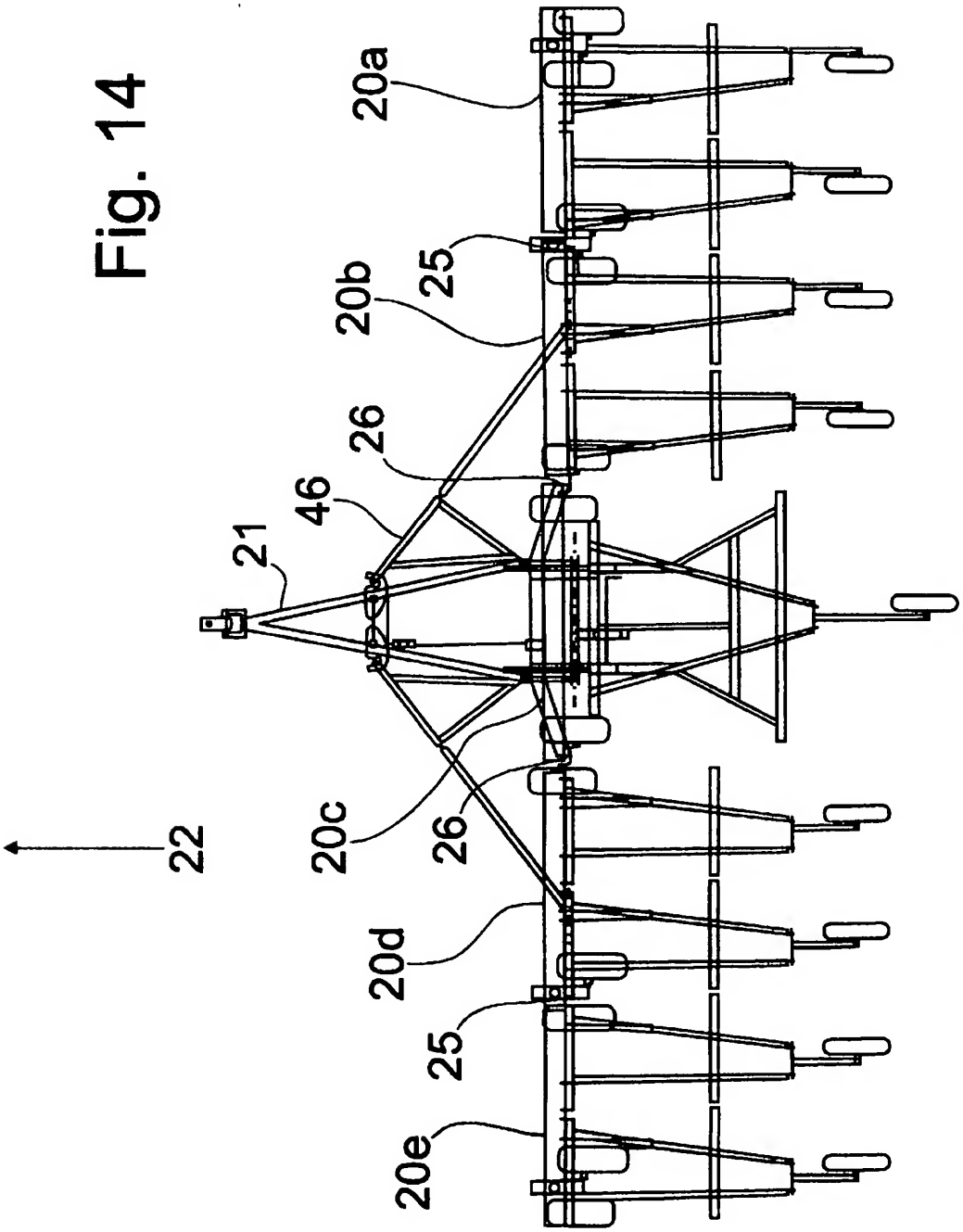
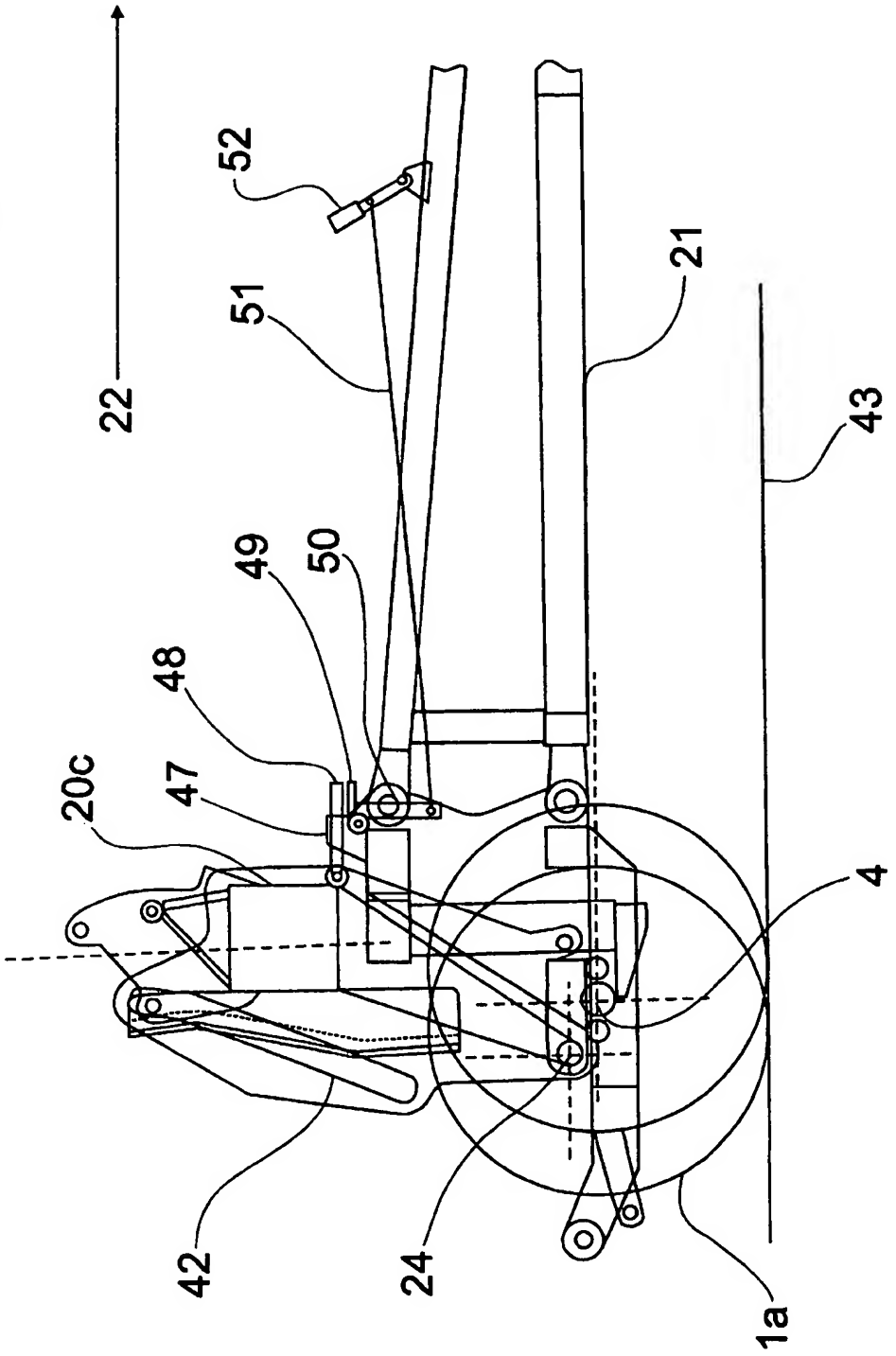


Fig. 15



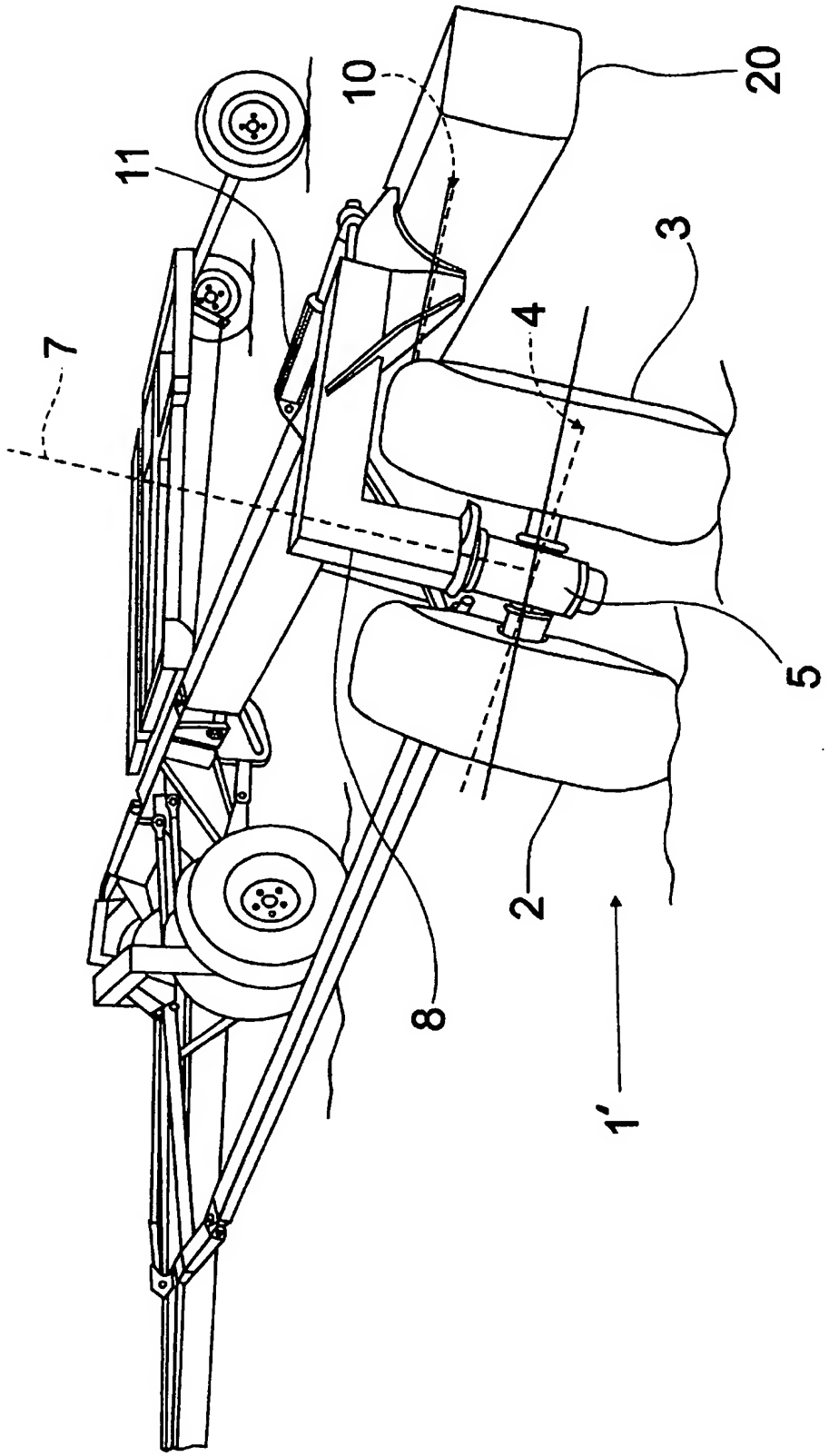


Fig. 16

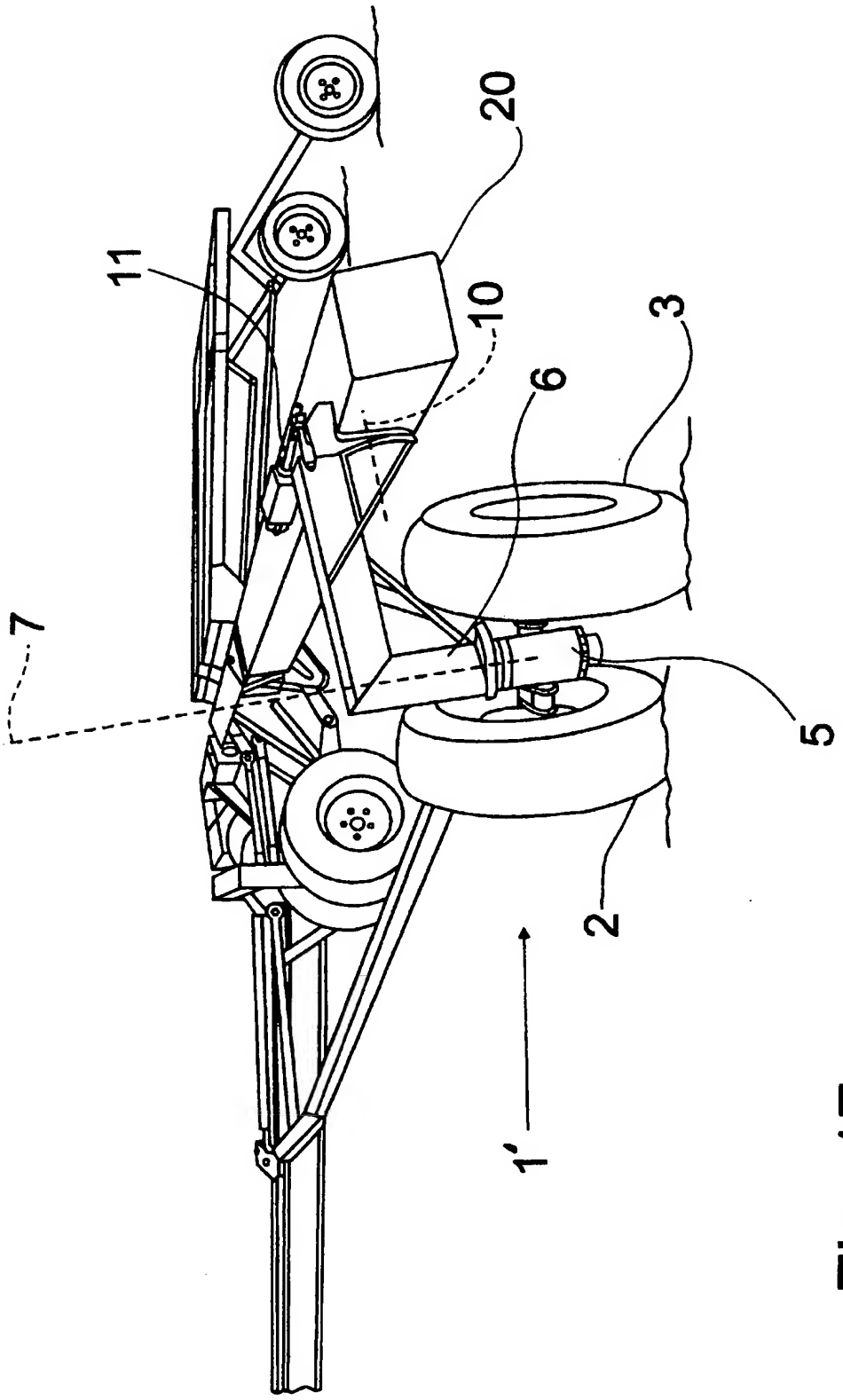


Fig. 17

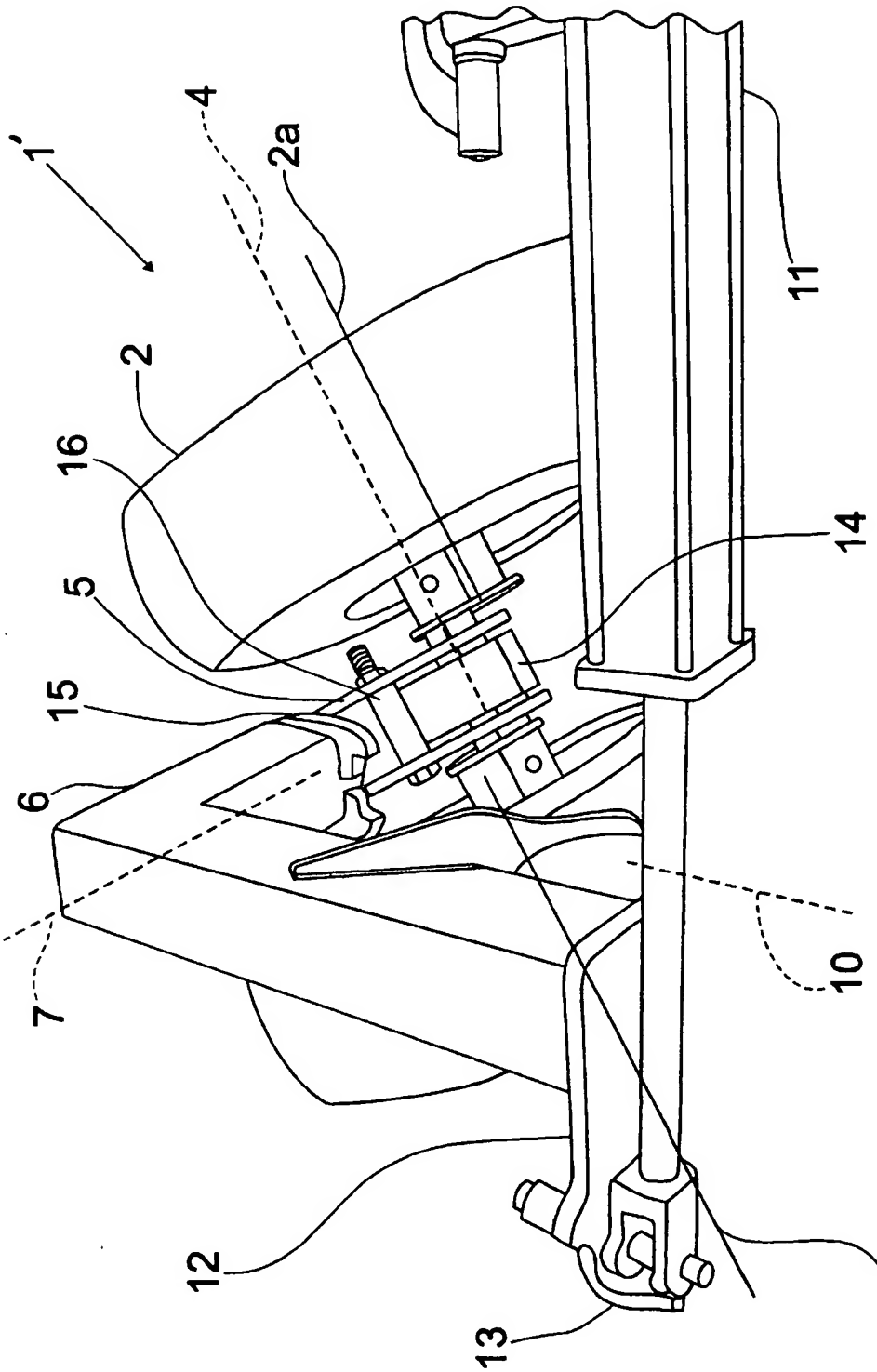


Fig. 18

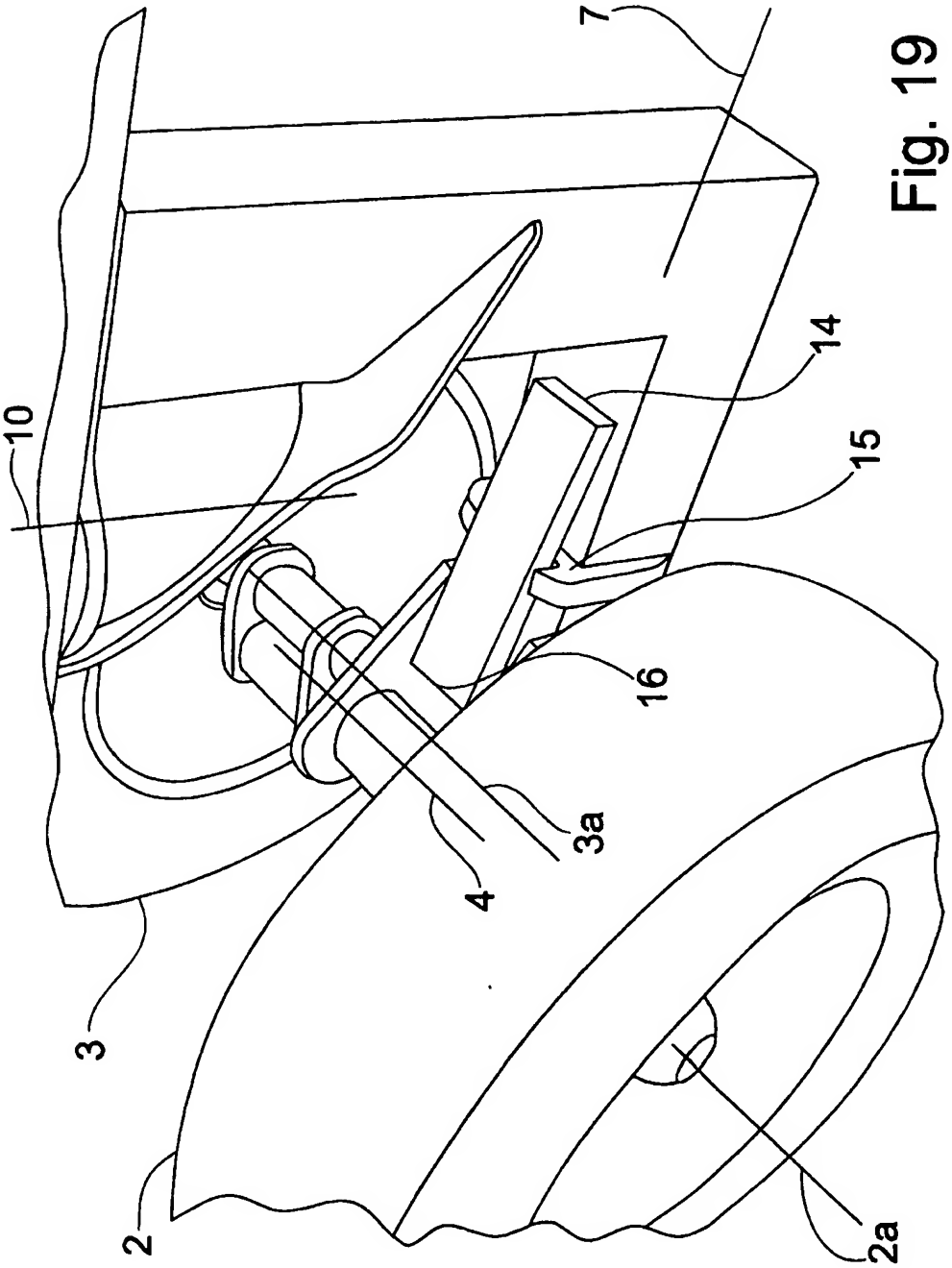


Fig. 19

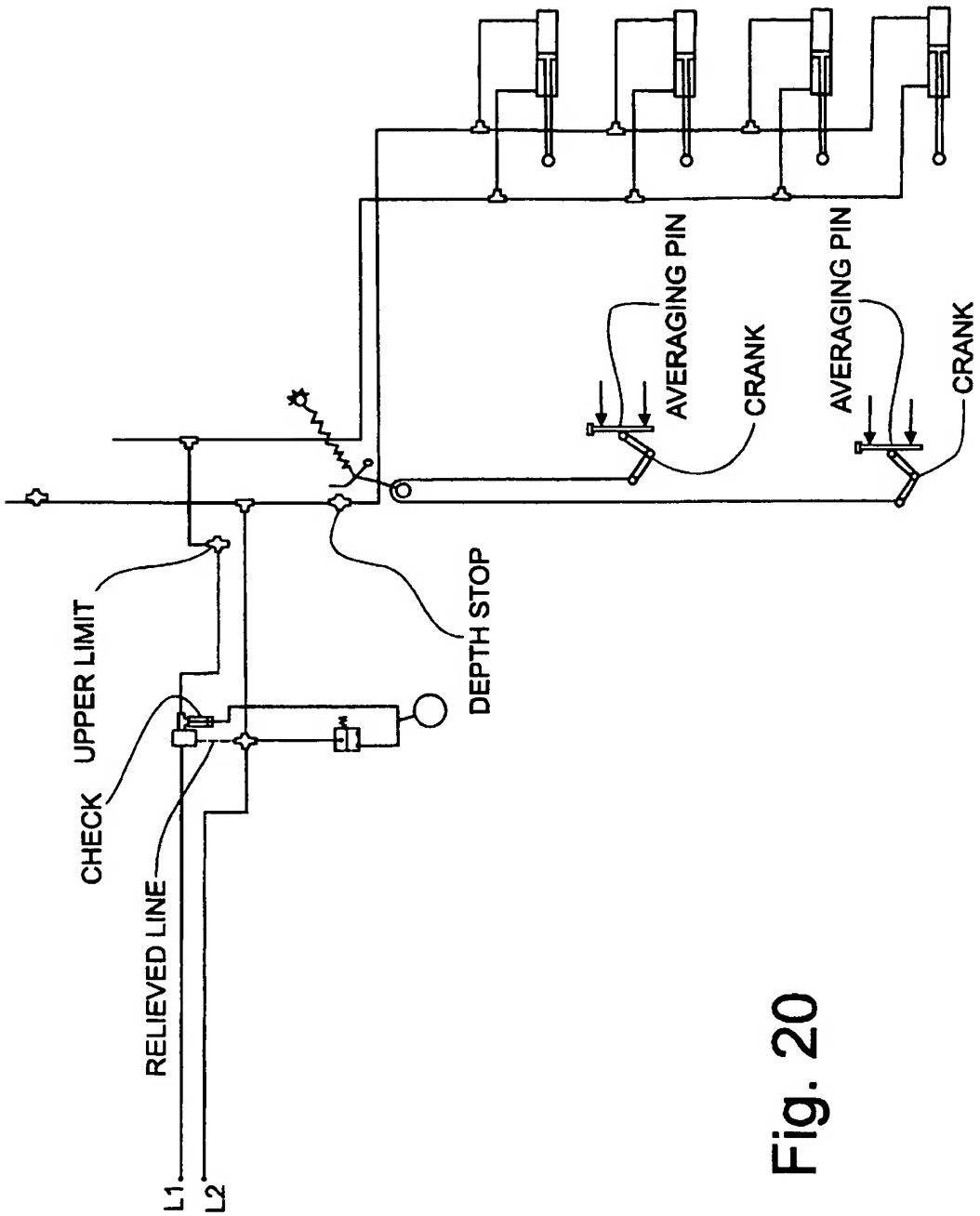

AVERAGING PIN
CRANK
AVERAGING PIN
CRANK
DEPTH STOP
UPPER LIMIT
CHECK
RELIEVED LINE
L1
L2

Fig. 20

Fig. 21

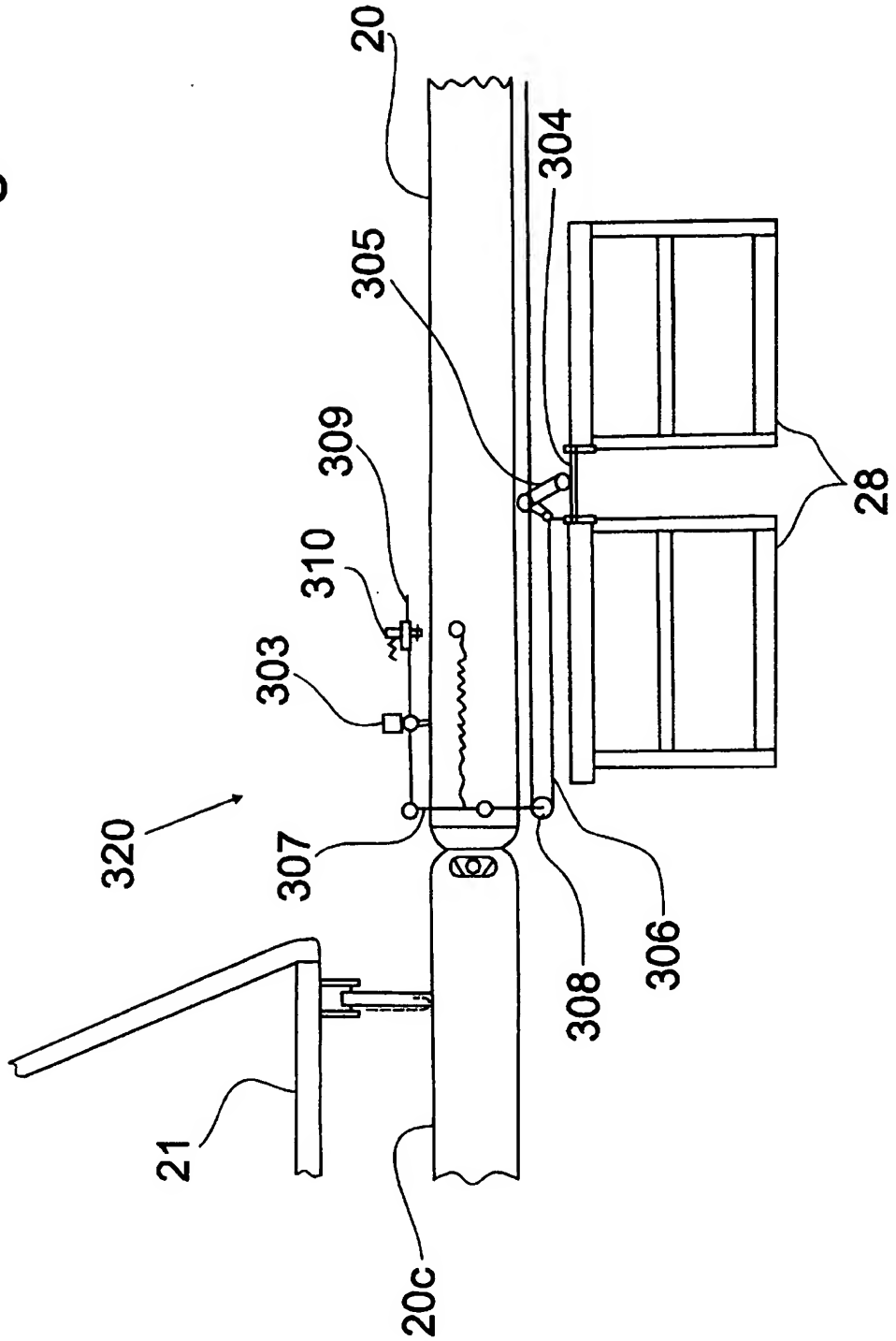
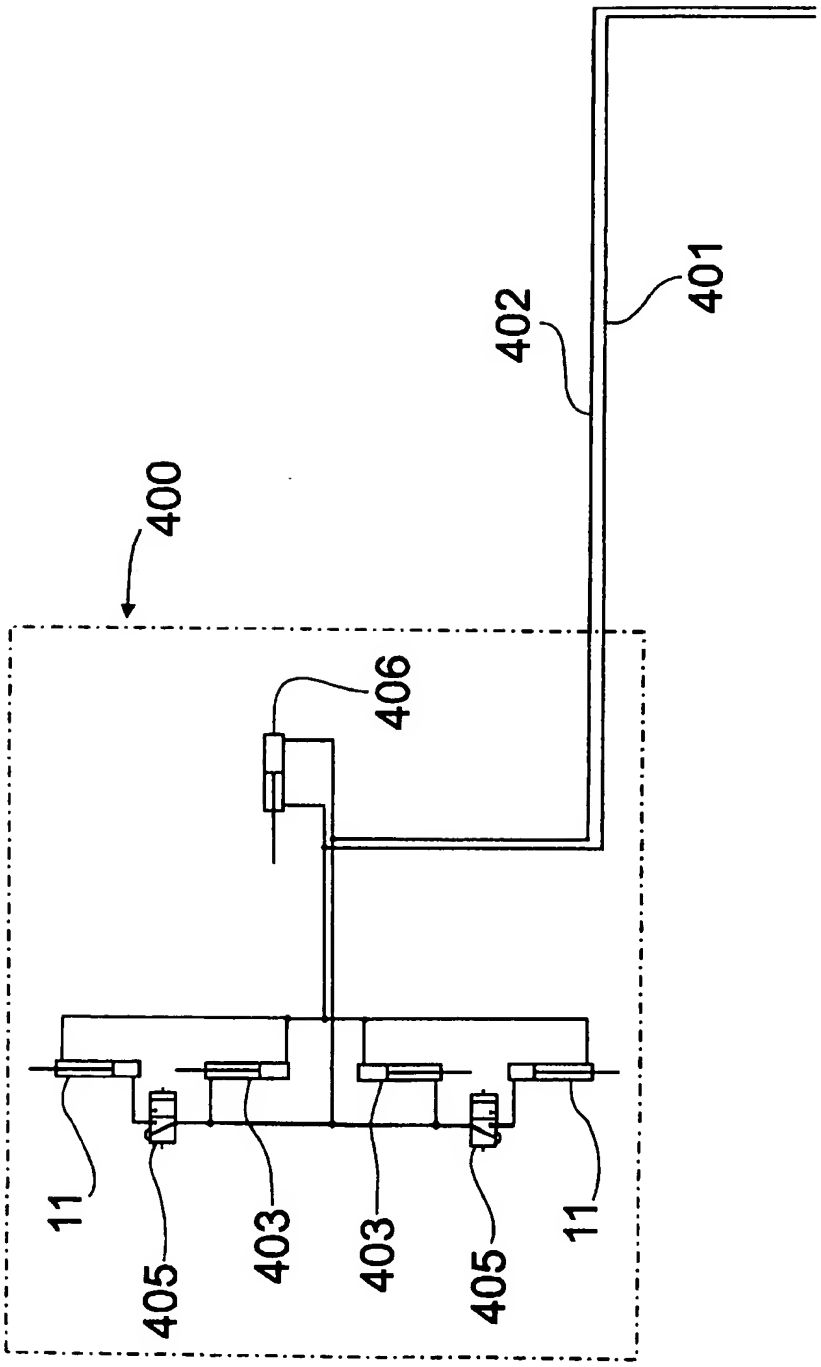


Fig. 22

Fig. 22a	Fig. 22b

Fig. 22a



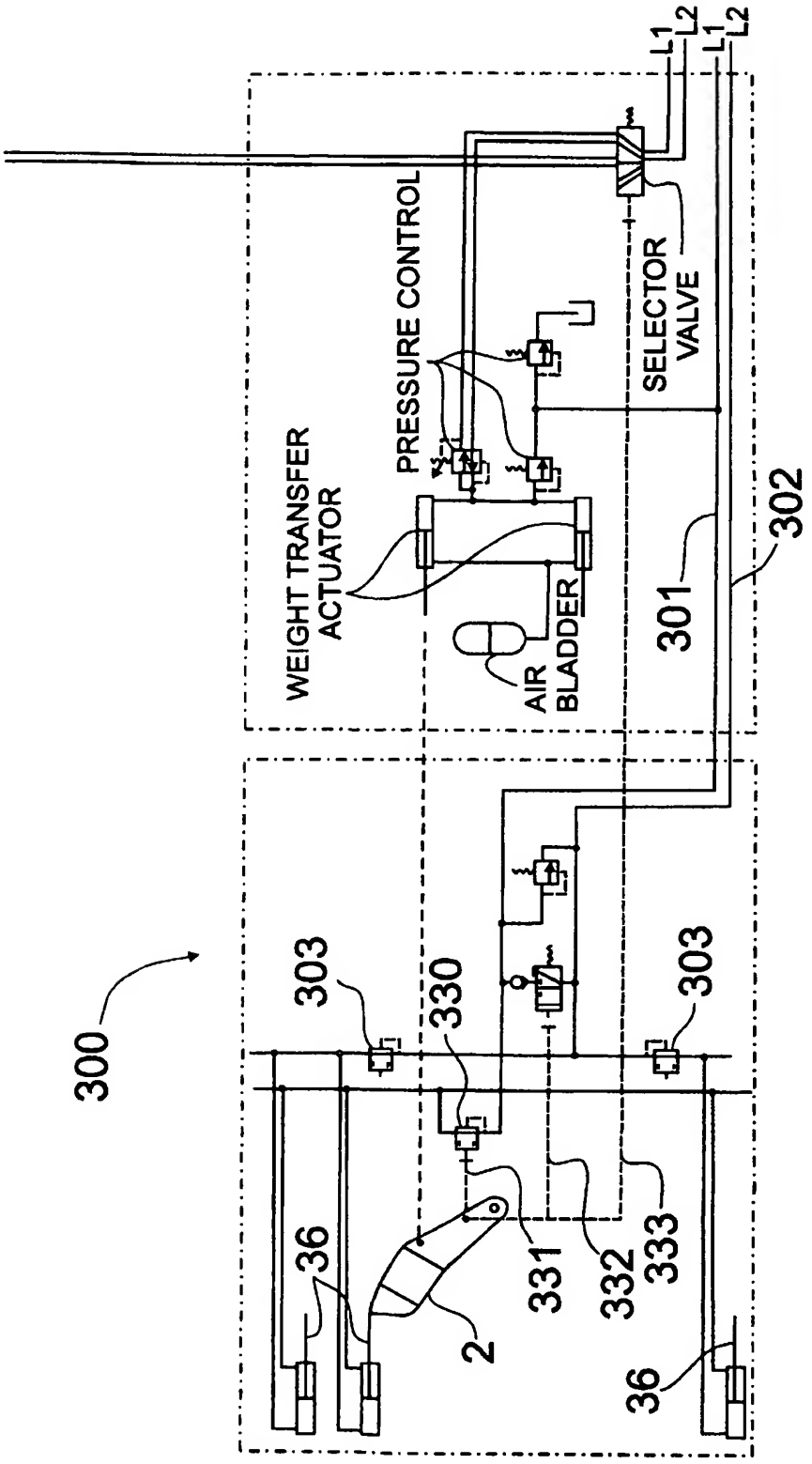

L1
L2
L1
L2
PRESSURE CONTROL
SELECTOR VALVE
WEIGHT TRANSFER ACTUATOR
AIR BLADDER
301
302
300
303
330
303
36
331
332
333
2
36

Fig. 22b

HYDRAULIC CONTROLS FOR AGRICULTURAL IMPLEMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims domestic priority on U.S. Provisional Patent Application Ser. No. 60/108,025, filed on Nov. 12, 1998, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates generally to agricultural implements such as cultivators that have a framework for supporting ground engaging tools that can be used for a variety of farming operations including tilling soil, applying fertilizer, and seeding. Implements such as these can be effectively used in different farming practices such as conventional-till, low-till, or no-till methods. Such implements required a framework through which, during operation, draft forces are transmitted with a minimum of moment forces being generated, which otherwise force some ground engaging tools to work deeper while causing others to work more shallow than the desired set working depth.

It is also desirable and common for implements of this type to have hitch frames pivotally connected to the front of the implement for connection to a pulling, vehicle, providing up-down movement of the forward end of the hitch relative to the implement so the implement frame is better able to remain parallel to the ground being engaged. There have also been implements of these types which have a framework of wing sections that pivot relative to one another along axis aligned with a direction of travel so the individual sections are able to remain parallel to respective sectional regions of the ground being engaged.

Known tillage implements have wings or sections pivotal to each other on axis that are angled from a direction of travel, providing some accommodation for ground that varies in slope in which the pitch varies from the left to right side of the implement framework. Other implements show a framework which is loosely jointed such that it can twist to accommodate such variations in ground pitch.

These implements of the prior art have served well to provide good ground following a depth control for a variety of farming operations. But it is yet desirable to provide an implement that has excellent ground following characteristics, yet also is capable of very compact folding. As farms become larger, implements are transported greater distances between fields. Implements of larger widths are being used to perform farming operations in reduced time. It is desirable to provide an implement that is available in large widths, is easily configurable for transport on roadways in which the implement is folded compactly having small dimensions in width and height for transport.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an implement with good ground following ability for consistent depth control across the whole implement, the implement being able to conform to variation in both ground pitch and roll.

It is also an object of this invention to provide an implement frame having such ground following characteristics which can be folded compactly for low and narrow transport.

It is also an object of this invention to provide an implement which is modular and capable of being configured when assembled for attachment of hoe or disc type ground engaging tools, and be used for either conventional-till, low-till, or no-till operations.

It is a further object of this invention to provide a framework through which biasing forces can be applied to transfer downward forces to distal ends of the framework.

These and other objects, features, and advantage are accomplished by the present invention by providing an agricultural implement, having ground engaging tools mounted on subframes that are movable through hydraulic actuators between raised transport and lowered working positions, with a hydraulic circuit in which the actuators are connected in parallel with one another within a grouping of the actuators. The positioning of the ground engaging tools into a lowered working position closes the hydraulic circuit for the group of actuators. The subframes are arranged to float over ground undulations to maintain a common working depth for the ground engaging tools. The vertical movement of any one of the actuators in the common group will force a displacement of a corresponding amount of hydraulic fluid, which will then be shared by all of the remaining actuators in the corresponding group. A depth averaging control for the ground engaging tools and a mechanical headland stop apparatus are also provided for the agricultural implement.

BRIEF DESCRIPTION OF DRAWINGS

The advantages of this invention will be apparent upon consideration of the following detailed disclosure of the invention, especially when taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a perspective view of a schematic diagram of a modular implement having a 5 section drawbar with subframes attached to each section of the drawbar, and is shown in a field working position;

FIG. **2** is a perspective view of the implement in FIG. **1** shown in a raised non-working position;

FIG. **3** is a perspective view of the implement in FIG. **1** shown with the drawbar fully rotated and raised to an intermediate position;

FIG. **4** is a perspective view showing subframes rotated to a generally vertical transport position;

FIG. **5** is another perspective view of the implement in FIG. **1** showing one of the wing sections of the drawbar folded rearwardly to a compact transport position;

FIG. **6** is a schematic side view of the implement in FIG. **1** shown in a working position, the ground engaging tools not being shown for purposes of clarity;

FIG. **7** is a schematic side view of the implement in FIG. **6** shown to be raised to a headland position;

FIG. **8** is a schematic side view of the implement in FIG. **6** shown with the drawbar fully rotated to the intermediate position as in FIG. **3**;

FIG. **9** is a schematic side view of a center subframe of the implement in FIG. **1**, shown in a working position;

FIG. **10** is a schematic side view of the center subframe in FIG. **9**, shown with the drawbar being rotatably raised to a headland position such as in FIG. **7**;

FIG. **11** is a schematic side view of the center subframe shown in FIG. **9**, shown in a low position with the drawbar being fully rotated and raised to the intermediate position as in FIG. **3**;

FIG. **12** is a schematic side view of the implement in FIG. **1**, showing wing subframes having been raised to a transport position and showing the center subframe remaining in a low position;

FIG. 13 is a schematic plan view of the implement in FIG. 1, shown in a working position;

FIG. 14 is a schematic plan view of the implement in FIG. 1, shown in the intermediate position;

FIG. 15 is a detail view of the hitch frame showing a locking mechanism for locking the drawbar to the hitch frame, restricting it from downward rotation;

FIG. 16 is an illustration of a modular implement like that shown in FIG. 1, but having only 3 drawbar sections, and showing the detail of a wing wheel assembly with its respective wheel position actuator, the drawbar being shown in a deep working position;

FIG. 17 is a illustration of the implement in FIG. 16 shown with the drawbar rotated to a shallow working position;

FIG. 18 is a detailed illustration of a wing wheel assembly caster locking mechanism and wheel position actuator, showing the locking mechanism unlocked, and the wheel assembly actuated to a field position;

FIG. 19 is the wheel assembly in FIG. 18 shown to be actuated to a transport position and the locking mechanism in the locked position, restricting the caster action of the wheel assembly;

FIG. 20 a hydraulic schematic showing a depth control hydraulic circuit with a depth averaging link illustrated and superimposed on the schematic;

FIG. 21 is a detail illustration of the depth averaging linkage attached to a drawbar wing section of a modular implement such as the one shown in FIG. 1; and

FIG. 22 is a comprehensive hydraulic schematic showing both the wing fold circuit and the subframe actuator circuit with mechanical links superimposed onto the schematic to illustrate a headland position control and other automatic control features.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A modular assembly of one configuration of an implement according to the invention is shown in plan view in FIG. 13. It is shown schematically in FIGS. 1–5, and side views of various positions of the implement are shown in FIGS. 6–12. It is shown having a hitch section 21 with a tongue 23 for connection to a pulling vehicle (not shown). The hitch section is supported on a set of ground wheel assemblies 1, which the support the hitch section 21 to roll above the ground as it is pulled in an operating or transport direction 22. Further direction references made within this description are made in relation to the operational direction 22. A drawbar 20 is pivotally attached to the hitch section 21 on a transverse pivot axis 24, at joints 24*a* and 24*b*. Subframes 27 and 28 are pivotally attached to the drawbar 20 and in a working position shown in FIG. 1 and FIG. 6. The subframes extend rearwardly of the drawbar and are supported parallel to the ground surface. Wheel assemblies 29 and 31 are pivotally attached to the rearward end of the subframes 28 and 27 respectively, for supporting the pivotal subframes at a level above the ground. The wheel assemblies 29 and 31 are linked to the drawbar 20 for coordinating the pivotal movement and position of the wheel assemblies with that of the drawbar as the drawbar 20 is pivotally operated about axis 24. Details of the coordination of these movements will be described in greater detail below.

The drawbar 20 extends laterally behind the hitch section 21 and is divided into sections with a center section attached to the hitch having a wing section attached to each lateral end of the center section. Wide models of the implement may have additional wing sections attached to each side, defining inner wing sections 20*b* and 20*d* and outer wing sections 20*a* and 20*e* of the drawbar on each side of the center section 20*c*. Each wing section is attached at a first end to an adjacent inner section an is supported by a wing wheel assembly 1' at a point toward a distal second end of the wing section. The wing attachment provides pivotal movement of the wing section so that the distal end is allowed movement up or down relative to the inner end when the drawbar is in any of its positions ranging from a working position to a transport position. In a working position, the drawbar 20 is rotated rearward and downward to set the ground engaging tools at a ground engaging depth within the ground. In an intermediate position the drawbar is rotated fully upward in which the ground engaging tools are raised out of contact with the ground. In the transport position, the drawbar wing sections are pivotally folded to trail rearwardly of the center section 20*c*, as seen in FIG. 5 which shows wings on one side of the implement folded so.

FIG. 6 shows that a subframe 28 is attached to the drawbar 20 and is pivotal relative to the drawbar about an axis 30. The pivotal movement of the subframe relative to the drawbar is controlled by an actuator 36 which is attached at one end 38 to the subframe and at another end 37 to the drawbar. As viewed in FIG. 6, retraction of the actuator will effect clockwise rotation of the subframe relative to the drawbar. A link 35 is connected at one end 39 to the drawbar and at another end 40 to the subframe wheel assembly 29. When the subframe is rotated clockwise relative to the drawbar 20, the link will allow the wheel assembly 29 to rotate clockwise relative to the subframe 28. As the subframe is rotated clockwise relative to the drawbar, and the wheel assembly is thus also rotated clockwise, then the subframe 28 will be lowered toward the ground. The link is connected to the drawbar 20 and wheel assembly 29 such that the amount of rotation of the wheel assembly 29 relative to the rotation of the drawbar 20, is such that the subframe 28 will be raised and lowered in a level manner through a working range of positions so that it is maintained parallel to the ground in such a range of positions. The rotation of the drawbar relative to the hitch remains free, so the hitch remains floating, as is common with many implements of this type. The portions of the frame supporting the ground working tools are supported by wheel assemblies 1, 1', 29 and 31, which are spaced close to each other in fore and aft relation so that the slope of the ground being engaged is closely followed by the framework of the implement which is supporting the ground engaging tools.

Optional actuators can be connected between the hitch section and the drawbar and used to bias the drawbar downward from the hitch section. This transfers the weight of the hitch section onto the drawbar so extra force is available to press the ground working tools into engagement with the ground to the desired set working depth. The subframes bear much of the weight of the drawbar when it is in the downward rotated position, the drawbar sections also being partially supported by wheel assemblies 1 and 1' so the drawbar remains at a constant height and follows a slope of land which may roll up or down to the left or right of the center of the implement. Pivotal movement of the subframes relative to the drawbar also accommodate variations in pitch of the ground up or down fore and aft of the implement. This pitch may vary from the left to the right side of the implement. The subframes are able to accommodate such variation in a manner described in more detail below.

A subframe 27 is shown attached to the drawbar center section 20*c* shown in a working position in FIG. 9. The

forward end of the subframe **27** is supported in a slot **42**, the slot being a part of a plate like member attached to the drawbar, the plate member also having a journal for attaching the drawbar to the hitch at axis **24**. The detail of the plate member is shown in FIG. **15**. Two such plate members are spaced laterally on the drawbar center section **20***c* to either side of the center of the section as can be seen in FIG. **13**. A track member is also attached to the drawbar center section which guides movement of the first end **41** of the wheel assembly link **35**. Link **44** is pivotally attached at one end to the hitch section and at the other end is pivotally attached to the subframe **27** at **30**. Link **42** is pivotally attached at one end to the hitch section **21** and at the other end is pivotally attached to the first end **41** of link **35**. As the drawbar is rotated, link **44** guides the movement of the subframe at point **30** along the slot **42**, while the link **44** guides the movement of the link end **41** along the track member. This maintains the center subframe in a low position when the drawbar is rotate fully up to the intermediate position. This provides clearance between the center subframe and ground engaging tools attached to the underside of the wing subframes when the drawbar wings are folded rearward to the transport position shown in FIG. **5**.

Modular Subframe Construction

The modular assembly of one configuration of an implement according to the invention is shown in plan view in FIG. **13**. This configuration is assembled with subframes that are adapted for attaching 2 rows of disc type ground engaging tools (not shown) on fore and aft transverse toolbars of each subframe. The subframes **28** and **27** are attached to a drawbar **20** and are attached laterally adjacent one another to extend transversely across a wide path on the ground. Subframes **28** which are to the right of the center of the drawbar are generally identical which has obvious manufacturing advantages, reducing cost of construction. Subframes **28** to the left of the center of the drawbar **20** are generally identical and symmetric to those on the right, also having cost reducing manufacturing advantages. A subframe **27** is attached to a drawbar center section **20***c*. This subframe is controlled differently from subframes **28** as has been described above.

An alternate subframe construction (not shown) is available for assembly with the drawbar, and when configured with such subframes, the implement is operable as a cultivator or hoe drill seeder. The alternate subframes can comprise of multiple transverse toollbars: 3, 4, or 5, as may be desirable for various arrangements of ground engaging tool supports (not shown) which can be attached to the toolbars as is common in cultivator construction. The alternate subframes of this configuration can be supported at the rearward ends by alternate wheel assemblies **29** and **31**, which can have a gang of press wheels attached at their first ends for rolling support of the subframe while also providing closing and packing of each of the furrows created by the ground engaging tools as the implement is pulled forward in operation. The press wheels are spaced so that there is one press wheel corresponding to each furrow created by the implement.

Parallel Actuator Hydraulic Circuit

As the implement is pulled across the ground, uneven slopes that roll and pitch may be encountered by the implement framework. The roll can be easily accommodated by jointed drawbar sections similar to that which is common on agricultural harrow implements and somewhat similar to conventional folding cultivators. Variations in pitch can also be accommodated by the present invention in a manner which is similar to that on agricultural harrow implements, the application of which was not before obvious as applied to cultivators and seeding implements which required the ground engaging depth of the ground engaging tools to be accurately controlled. The present invention provides rear wheel assemblies on each of the subframes of the implement so both the forward and rearward end of the subframes are controlled to a set height. The rear wheel assemblies of the present invention are pivotally attached, the movement of which is coordinated with the movement of the drawbar supporting the forward end of the subframes so that the subframes can be easily adjusted to various heights in a range of working positions in which the subframes are maintained parallel to the ground.

Actuators **36**, which control the movement of the drawbar and thereby the movement of the subframes, are connected in parallel for simultaneous operation of all the subframe actuators in a common circuit. The connection of the actuators to a common drawbar maintains their retraction and extension in a synchronized manner so the subframes move between various working positions in unison at remain at equal working heights. The subframes are provided independent movement relative to each other about the drawbar pivots **30** so that their frame heights remain equal regardless of variations in ground elevation and slope differences between the subframes from the left to right sides of the implement. When the implement is set at a working position, the circuit controlling the subframe actuators is closed, yet the subframe actuators are still able to communicate fluid between themselves to allow the subframes continued independent movement.

The center subframe **27** is not controlled by an actuator and is positionable by the rotation of the drawbar, the drawbar being controlled by the actuators **36** of the subframes **28**.

Depth Averaging Control

FIG. **22** schematically shows a depth control circuit **300** for controlling the depth of the ground engaging tools by controlling the movement of the subframe actuators **36**. When the subframes are lowered to a working position by retraction of the actuators **36**, the implement may not be positioned over level ground. Some subframes may pitch upward at the forward ends relative to others which may be pitched less upward, or even downward.

To lower the implement to a working height, hydraulic pressure is applied to circuit **300** in line **301**. This cause actuators **36** to retract, rotating the subframes clockwise relative to the drawbar and rotating the drawbar ccw and downward as viewed schematically in FIG. **22**. Fluid displaced from the base ends of actuators **36** during their retraction is returned to the hydraulic reservoir, not shown, via line **302**. Depth stop valves **303** are actuated when the level of the subframes has approached a set working height, and flow to line **302** is blocked restricting flow in or out of circuit **300**. Actuators **36** of the preferred embodiment are connected to the circuit **300** in two groups, the groups being separately controlled by individual depth stop controls **303**. The drawbar wing sections of the preferred implement are provided with rotational movement relative to the center section **20***e*. Thus the rotation of the drawbar wing sections to the left and right of the center section are controlled separately by the two depth control valves **303** as shown. As each wing section or sections to the left or right of the center section approach the set working position, the respective depth stop control is actuated stopping the drawbar rotation to a set position.

FIG. **21** illustrates a depth stop linkage which actuates the depth stop control valve **303**. An averaging link **304** is

connected to adjacent subframes that are attached to a common drawbar wing section. One, two, or more subframes may be attached to each drawbar section. When two or more are attached it is desirable to use their average position for actuating a depth stop control, so that the drawbar section is set at an average height not effected by a severely pitched position of any one subframe, which may happen if the subframe is on pitched ground, or if the subframe wheel assembly **29** is resting on a clod or rock. A central part of the averaging link **304** abuts a depth control crank **305**. The crank **305** is rotated according to the relative rotation between the drawbar and adjacent subframes. The crank **305** is linked to a lever **307** by a linking member **306**. The lining member **306** may be directly connected to lever **307**, or for an implement having inner and outer wing sections, it can be indirectly linked to the lever **307** as shown in FIG. **21**.

A second pair of adjacent subframes (not shown) which are attached to an outer wing section, have an identical averaging link **304** acting on an identical crank **305**, to which a link **306** is also connected. Links **306** can be connected to an intermediate lever on one end of lever **307** for averaging the actuation of the links **306**, or as shown, link **306** can be a continuous cable with each end attached to cranks **305** with an intermediate portion of the cable looped around a pulley **308** for averaging the actuation of the cable from both ends by cranks **305**. This averaged cable displacement rotates lever **307**. A link **309** attached to the other end of the lever **307** is thereby operated in a linear manner. A depth stop **310** is adjustably positioned on the link **309**, and is setable to a position corresponding to a desired set working height of the implement framework. When the drawbar is lowered and the subframes pivot relative to the (drawbar to actuate the depth averaging link **320**, the depth stop **309** will actuate the stop valve **303**, stopping further rotation of the drawbar and holding the respective subframes at a set working height.

Headland Position

FIG. **22** also shows headland stop valve **330**. A linkage **331** attached to the drawbar **20** is shown schematically which actuates the headland stop valve **330**, when the drawbar reaches a certain position when being raised from a working position in which ground engaging tools are engaging the ground, to a position in which the ground engaging tools are raised out of contact with the ground. The headland link (not otherwise shown) includes a stop which is adjustable along the length of the link. The stop can be set to actuate the headland valve **330**, when the drawbar is raised to a position about **30** degrees up from the working position as shown in FIG. **7**. This is a position to which the implement is raised at field headlands to raise the ground engaging tools just enough to allow turning of the implement at headlands. This can be a position in which the ground engaging tools are out of contact with the ground, or in which the tools are in shallow contact with the ground, providing a sweeping action so no wheel tracks remain visible where the implement is turned. From this position the implement ground engaging tools can be more quickly set back to a working depth.

A bypass linkage (not shown) is connected a drawbar locking crank **50** which is visible in FIG. **15**. The lock crank **50** is operable from handle **52** and can be positioned to abut with lock **48** that is attached to the drawbar **20**, lifting it out of engagement with lock hook **47** that is attached to the hitch section **21**. When the crank **50** is rotated clockwise as viewed in FIG. **15**, then the lock **48** is engagable with hook **47** when the drawbar becomes fully raised up. The bypass link (not shown) is also operated by crank **50** so that it shifts the alignment of headland link **331** (also not shown in FIG. **15**) so that it does not engage the headland stop **330** as the drawbar is being raised up. In this way the drawbar can be fully raised up and not stopped at the headland position.

An alternate implement used for supporting precision row planting devices, is provided with a similar headland position stop. The mechanism of operation of the headland stop in this implement is different, but the general function is the same. The planting implement comprises a drawbar hitch for connection to a pulling vehicle, a transversely extending toolbar pivotally attached to the drawbar about a transverse axis for rotation between a downward working position and upward non-working positions, and having planting devices attached in spaced relation along the toolbar. The implement includes a hydraulic circuit with a toolbar actuator for rotating the toolbar between positions, and hydraulic valves for controlling the hydraulic circuit.

The implement also includes an electronic control system which is connected to solenoids that operate various hydraulic valves within the hydraulic circuit, and in particular, controls the operation of a toolbar actuator valve to allow or restrict hydraulic flow which operates the toolbar actuator. The headland stop control comprises a proximity sensor attached to the drawbar, the sensor being of the type which has electrical characteristics which change when a ferrous material is placed proximate to the sensor. The toolbar of the implement has attached to it a steel plate which works in cooperation with the proximity sensor. The position of the headland sensor is adjustable on the drawbar so that the position of the toolbar in which the steel plate becomes proximate to the sensor can be adjusted to vary the headland position. As the toolbar is being raised from a working position to a non-working position, the steel plate is rotated with the toolbar and becomes proximate to the headland sensor. This signals the electronic controls system to cause actuation of the toolbar hydraulic valve to stop the upward movement of the toolbar.

The electronic control system includes an override switch which, among other functions, interrupts the headland stop signal so that the toolbar may be raised to a fully upwardly rotated position. As for the headland stop position of the implement previously described, the headland stop control of this alternate implement stops the toolbar when it is being raised at headlands, at a position from which it can be more quickly be reset to a working position again than if it had to travel from a more upwardly raised position.

Unfold Circuit with Wheel Control in Combination

The implement shown in FIG. **13** includes wing wheel assemblies **1'** for supporting the drawbar wing sections as described above. The wing wheel assembly **1'** is shown in greater detail in FIG. **18**. A wing wheel assembly is attached near the distal end of each wing section **20***a*, **20***b*, **20***d*, and **20***e*. The assembly has a main strut **6** which is attached to a wing drawbar section by a journal arrangement having a steering axis **10**. A lockable caster arm **5** is pivotally supported by the strut **6** and, when not locked, provides caster motion to the wheel assembly. Wheels **2** and **3** are pivotally supported on parallel axles having axes **2***a* and **3***a*, the axles being attached to a walking beam axle having walking axis **4**, with axes **2***a* and **3***a* being offset an equal distance from the walking axis **4**.

A lock member **14** is pivotally supported by a bolt running through journal **16** and is free to pivot by the force of gravity. The lock **4** is adapted to fit within a locking saddle **15** which is fixed to the strut **6**, and when engaged in the saddle **15**, prevents rotation of the caster arm **5** about axis **7**. The wing

wheel assembly is pivotally controlled by a wheel steering actuator **11**, connected at one end **13** to the strut **6**, and at the other end to the drawbar wing. Extension and retraction of the wheel steering actuator **11** effects rotation of the wing wheel assembly **1'** about the steering axis **10**. The caster axis **7** is generally vertical when the drawbar **20** is rotated within a range of field positions, which is a range including a working position and a headland position, although it may be somewhat inclined forward or rearward.

The walking beam arrangement accommodates various positions of the caster axis while maintaining both wheels of the assembly on the ground so the height of the drawbar remains generally constant as the caster rotates and so that the load is evenly distributed. As the drawbar **20** is rotated upward to a transport position, the caster axis **7** becomes generally horizontal and lock **14** is pivoted by gravitational force to rest against saddle **5**. If it does not immediately engage in the saddle, then it will soon become engaged during folding of the drawbar wings or as transporting of the implement begins to restrict rotation about axis **7** and provide stability to the wheel assembly during transport.

The wing wheel assemblies **1'** of the drawbar wing sections are steered into alignment for either transport of field operation. The movement of a wing wheel assemblies **1'** is controlled by an actuator **11** which is connected to a common circuit wing fold circuit **400** in parallel hydraulic connection with wing fold actuators **403** (not shown) that are connected between the drawbar center section and inner wing section. The number of hydraulic circuits requiring connection to the pulling vehicle is thereby minimized by having such a combination circuit. The wing wheel actuator **11** operation is sequenced by a hydraulic valve **405** so the wheel assembly **1'** is steered at the appropriate moment during the folding and unfolding of the implement wing sections.

Folding Sequence

1. To configure the implement for transport from a field position, the subframes are raised and the drawbar wings are folded. The wing wheel assemblies are steered in sequence as the drawbar wings are folded. The sequence begins by first setting the drawbar lock handle **52** to a locking position so that locks **48** are ready to engage hooks **47**. This sets the headland link **331** to bypass the headland stop valve **330**.
2. Hydraulic pressure is then applied to line **302** to cause subframe actuators **36** to extend and fully rotate the drawbar **20** until it is locked with the hitch section **21**, restricting its rotation.
3. Hydraulic pressure is then applied to line **301** to cause subframe actuators **36** to retract. With the drawbar **20** locked, the subframes **28** are raised off the ground to a generally upright transport position as shown in FIG. **12** and FIG. **4**.
4. Now pressure is applied to line **401** of the hydraulic fold circuit **400**. This first causes a draft arm lock actuator **406** to retract to unlock draft arm locks, releasing draft arms which otherwise support the drawbar wing sections during field operation. After this is complete, the pressure increases to extend the wing fold actuators **403**, folding the drawbar wing sections rearwardly.
5. As a drawbar wing section is nearly completely folded to a transport position as shown in FIG. **5**, then a wheel actuator link (not shown), being responsive to the drawbar wing rotation, actuates the wheel actuator sequence valve **405** to allow hydraulic fluid to flow from the base end of wheel actuator **11** to the hydraulic reservoir (not shown). The actuator **11** is then retracted and the wing wheel assembly **1'** is steered about 90 degrees about the now upright steering axis **10** to align the wheels in a direction suited for transport as the wings become completed folded back.

Unfolding Sequence

1. To unfold the implement to a field operating configuration the sequence is reversed. Pressure is first applied to line **402** to unfold the wings, but the pressure first causes the draft arm lock actuator **406** to extend and wheel actuators **11** to extend and the wing wheel assemblies **1'** to be steered about 90 degrees to align the wheels about perpendicular to the transport direction. The draft arm locks (not shown) are now ready to engage with the ends of draft arms **46** so they become locked with the hitch section **21**. They are spring biased to allow the locks some pivotal motion during engagement. When movement of the lock actuator **406** and wing wheel actuators **11** is complete, the pressure increases to cause the wing fold actuators **403** to retract and unfold the wings to a laterally aligned position.
2. Pressure is now applied to line **302** to cause subframe actuators **36** to extend and lower the subframes **28** to be generally parallel with the ground and so they are supported at their rearward ends by wheel assemblies **29** such that the weight of the drawbar is relieved from the locks **48** and the locks **48** can be disengaged from lock hooks **47**.
3. Pressure is now applied to line **301** to cause the subframe actuators **36** to retract, rotating the drawbar **20** downward to a field operating position. At this time the caster lock **14** will fall out of engagement with saddle **15** to allow the castering motion about the now generally vertical axis **7**.

It will be understood that changes in the details, materials, steps and arrangements of parts which have been described and illustrated to explain the nature of the invention will occur to and may be made by those skilled in the art upon a reading of this disclosure within the principles and scope of the invention. The foregoing description illustrates the preferred embodiment of the invention; however, concepts, as based upon the description, may be employed in other embodiments without departing from the scope of the invention. Accordingly, the following claims are intended to protect the invention broadly as well as in the specific form shown.

Having thus described the invention, what is claimed is:

1. In an agricultural implement having a hitch adapted for connection to a prime mover; a drawbar movably attached to said hitch for movement between a working position and a raised transport position, said drawbar having a pair of wings movable relative to one another; a plurality of subframes movably attached to said drawbar, said subframes being arranged in groups corresponding to said wings, each respective said subframe carrying ground engaging tools; a hydraulic actuator interconnecting said drawbar and each of said subframes to effect movement of each respective said subframe relative to said drawbar, the improvement comprising:

a hydraulic circuit including a pump, a reservoir, and hydraulic lines interconnecting said hydraulic actuators in parallel, said actuators being operable to raise said subframes from a working position to a transport position, said hydraulic circuit further including a depth stop valve for each respective group of actuators, said depth stop valves being operable when said subframes

of the corresponding group reach said working position to close said hydraulic circuit for the subframes of the corresponding group such that said hydraulic actuators of the corresponding group remain in communication with each other without hydraulic fluid entering or leaving said corresponding group of actuators;

wherein the movement of said drawbar relative to said hitch actuates said depth stop valves when said subframes reach said working position.

2. The agricultural implement of claim 1 wherein said subframes are provided with a rearwardly positioned support wheel, each said subframe being vertically movable relative to the remaining subframes corresponding to said group of actuators to follow ground undulations.

3. The agricultural implement of claim 2 wherein the vertical movement of one of said actuators of said group displaces hydraulic fluid within said closed circuit, the displaced hydraulic fluid being distributed throughout said closed circuit such that the remaining actuators of said group are vertically moved in response to said distributed hydraulic fluid in a vertical direction opposite of said one actuator.

4. The agricultural implement of claim 1 wherein at least two of said subframes in each respective said group are connected to an averaging link which is operably associated with the corresponding said depth stop valve for actuation thereof according to an average depth of said connected subframes.

5. The agricultural implement of claim 4 wherein a central portion of said averaging link abuts a depth control crank which is connected to an adjustable stop member to engage said depth stop valve when the average position of said connected subframes reaches said predetermined working position.

6. The agricultural implement of claim 5 wherein hydraulic circuit circulates hydraulic fluid between said actuators and said reservoir when said depth control valve is not engaged so that said subframes can be moved to said raised transport position.

7. The agricultural implement of claim 6 wherein said hydraulic circuit further includes a headland stop valve that is cooperable with said drawbar to limit the movement of said drawbar from said working position toward said raised transport position to a headlands position in which said ground engaging tools have been raised above the ground so that said agricultural implement can be re-oriented before returning said ground engaging tools to said working position.

8. An agricultural implement for working the ground comprising:

a hitch adapted for connection to a prime mover;

a drawbar movably attached to said hitch for movement between a working position and a raised transport position;

a plurality of subframes movably attached to said drawbar, said subframes carrying ground engaging tools movable between a working position and a raised transport position relative to said drawbar, each said subframe having a hydraulic actuator connected to said drawbar to effect movement of each respective said subframes relative to said drawbar, said actuators being arranged in at least two groups;

a hydraulic circuit including a reservoir, a pump to provide a flow of hydraulic fluid under pressure to said hydraulic actuators, and hydraulic lines interconnecting said hydraulic actuators to said reservoir and said pump; and

a depth control valve associated with each said group of actuators, each said depth control valve being operable to close said hydraulic circuit for the corresponding said group of hydraulic actuators, the hydraulic actuators in each group being connected in parallel in a circuit such that said hydraulic actuators remain in communication with each other when said circuit is closed;

wherein at least two of said subframes in each respective said group are connected to an averaging link which is operably associated with the corresponding said depth stop valve for actuation thereof according to an average depth of said connected subframes; and

wherein a central portion of said averaging link abuts a depth control crank which is connected to an adjustable stop member to engage said depth stop valve when the average position of said connected subframes reaches said predetermined working position.

9. The agricultural implement of claim 8 wherein the vertical movement of one of said actuators of said group displaces hydraulic fluid within said closed circuit, the displaced hydraulic fluid being distributed throughout said closed circuit such that the remaining actuators of said group are vertically moved in response to said distributed hydraulic fluid in a vertical direction opposite of said one actuator.

10. The agricultural implement of claim 9 wherein said drawbar includes a pair of wings, said group of hydraulic actuators corresponding to one of said wings.

11. The agricultural implement of claim 8 wherein a central portion of said averaging link abuts a depth control crank which is connected to an adjustable stop member to engage said depth stop valve when the average position of said connected subframes reaches said predetermined working position.

12. The agricultural implement of claim 11 wherein said hydraulic circuit further includes a headland stop valve that is cooperable with said drawbar to limit the movement of said drawbar from said working position toward said raised transport position to a headlands position in which said ground engaging tools have been raised above the ground so that said agricultural implement can be re-oriented before returning said ground engaging tools to said working position.

13. An agricultural implement for working the ground comprising:

a hitch adapted for connection to a prime mover;

a drawbar movably attached to said hitch for movement between a working position and a raised transport position;

a plurality of subframes movable attached to said drawbar, said subframes carrying ground engaging tools movable between a working position and a raised transport position relative to said drawbar, each said subframe having a hydraulic actuator connected to said drawbar to effect movement of each respective said subframes relative to said drawbar, said actuators being arranged in one or more groups;

a hydraulic circuit including a reservoir, a pump to provide a flow of hydraulic fluid under pressure to said hydraulic actuators, and hydraulic lines interconnecting said hydraulic actuators to said reservoir and said pump, said hydraulic circuit further including a depth control valve associated with each said group of actuators, each said depth control valve being operable to close said hydraulic circuit for the corresponding said group of hydraulic actuators; and

an averaging linkage interconnecting at least two of said subframes in each respective group to define an average depth with respect to said interconnected subframes, said averaging linkage being cooperable with the corresponding said depth stop valve for actuation thereof when said average depth corresponds to said working position for said subframes.

14. The agricultural implement of claim 13 wherein a central portion of said averaging link abuts a depth control crank which is connected to an adjustable stop member to engage said depth stop valve when the average position of said connected subframes reaches said predetermined working position.

15. The agricultural implement of claim 14 wherein the hydraulic actuators in each group being connected in parallel such that said hydraulic actuators remain in communication with each other when said circuit is closed.

16. The agricultural implement of claim 15 wherein the vertical movement of one of said hydraulic actuators in each respective group displaces hydraulic fluid within the closed hydraulic circuit corresponding to said respective group, the displaced hydraulic fluid being distributed throughout said closed hydraulic circuit so that the remaining hydraulic actuators of said respective group are vertically moved in response to said distributed hydraulic fluid in a vertical direction opposite of said one hydraulic actuator.

* * * * *

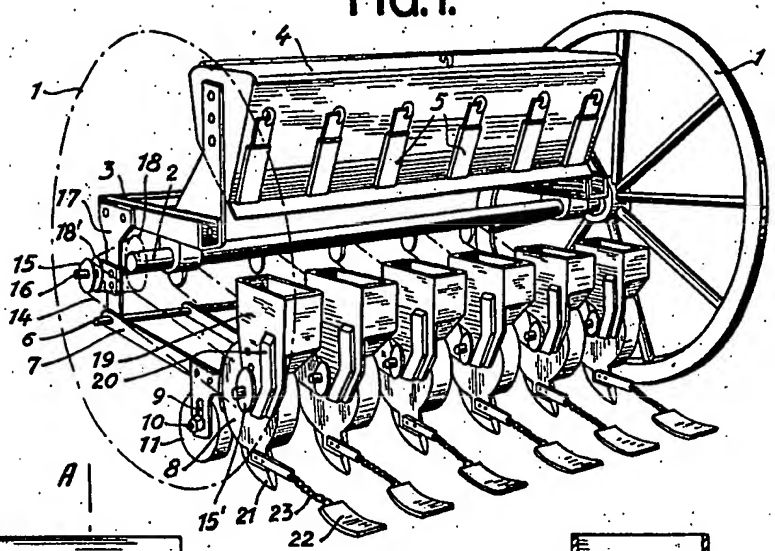
Oct. 13, 1925. 1,556,850

G. KÜHNE

MACHINE FOR SOWING SEED

Filed March 29, 1924 2 Sheets-Sheet 1

FIG.1.



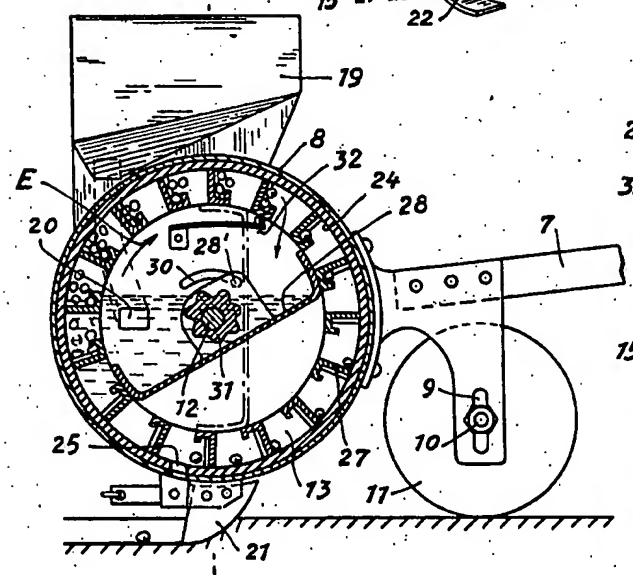


FIG.2.

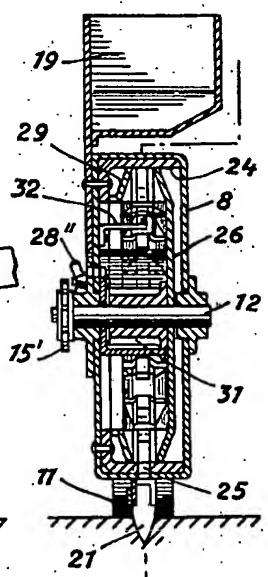


FIG.3.

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MACHINE FOR SOWING SEED

Filed March 29, 1924 2 Sheets-Sheet 2

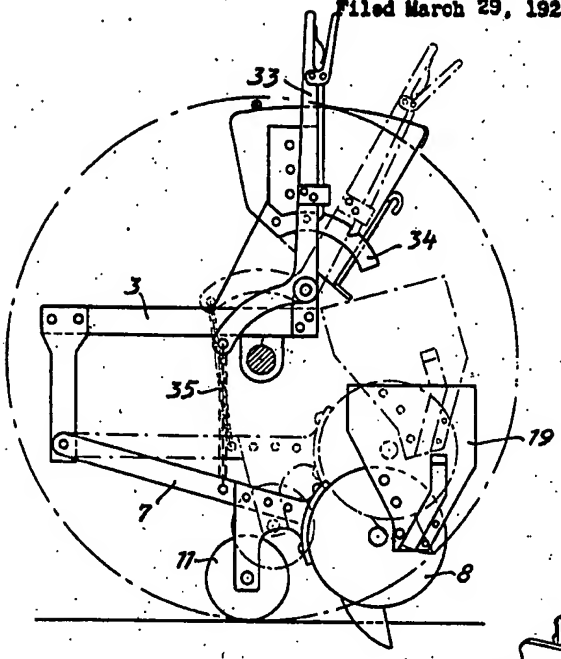

FIG. 4.

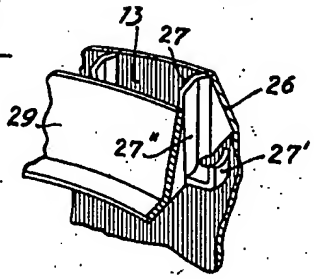

FIG. 7.

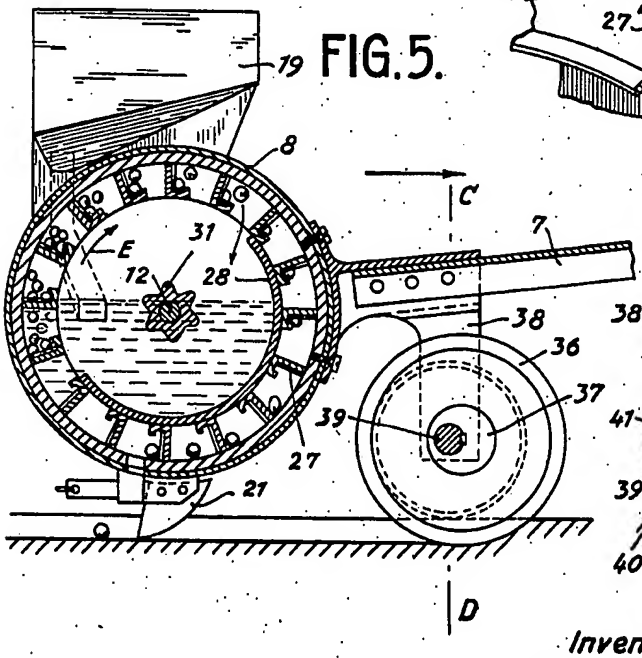

FIG. 5.

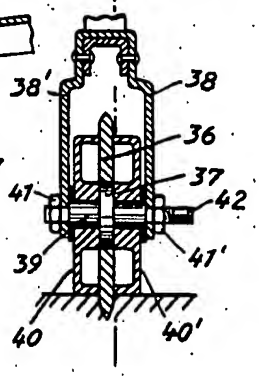

FIG. 6.

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Patented Oct. 13, 1925. 1,556,850

UNITED STATES PATENT OFFICE.

GEORG KÜHNE, OF KONIGSBERG, GERMANY.

MACHINE FOR SOWING SEED.

Application filed March 29, 1924. Serial No. 702,933.

To all whom it may concern:

Be it known that I, GEORG KÜHNE, a German citizen, residing at Konigsberg, Pr., Germany, have invented new and useful Improvements in a Machine for Sowing Seed, of which the following is a specification.

The invention relates to a machine for sowing corn or the like grain by grain, which as a mobile machine can be drawn over the prepared field to deposit the seeds singly in each individual row with a predetermined equal spacing, whereby the plants growing from the isolated seeds are afforded most generous growing conditions, namely an ample spacing and correct depth in the earth for germination.

In the new machine one or more chain driven sowing wheels provided with a number of buckets having spoon-like devices conforming to the shape of the seed are driven through a supply of seed. Surplus seeds fall back by gravity to the supply receptacle and ultimately only a single seed is retained by each spoon and ejected through an aperture in the wheel casing. The seeds are isolated and deposited by one mechanism and an auxiliary device need not be employed to cause the rejected seeds to pass back to the sowing wheel.

In order that the seeds may be planted at the correct depth in the ground, an adjustable furrowing device is provided.

The sowing wheel can be raised or lowered into inoperative or operative position by lever and quadrant means in known manner.

The appended drawings show an example of corn separating and sowing machine according to the invention.

Figure 1 is a perspective view of a machine capable of sowing six rows simultaneously; Fig. 2 is a part sectional view of sowing wheel with feeding hopper and carrier; Fig. 3 is a section on line A—B of Fig. 2; Fig. 4 is an elevation showing the controlling mechanism; Fig. 5 is a view of a modified form of wheel from that shown in Fig. 2; Fig. 6 is a section on line C—D of Fig. 5; Fig. 7 is an enlarged fragmentary view of a cell of the sowing wheel.

The carriage of the machine comprises two transport wheels 1 fast on an axle 2 upon which the frame 3 is pivoted. This carries a box 4 for the supply of seed, having an inclined rear wall, provided with a number of slides 5 which when open allow seed to escape. In the frame 3 is horizontally arranged a rod 6 upon which pivot arms 7 carrying the cylindrical wheel casings 8. The arms 7 are supported by rollers 11 having pivots 10 adjustable in slots 9 whereby the depth of furrow may be regulated.

In each wheel casing 8 is rotatably mounted a shaft 12 upon which is fixed the sowing wheel 13. The drawings show one wheel in each casing, but more than one could be arranged in a suitable casing if desired. The shaft 12 is driven by chains 14, whereof the chain wheels 15, 15^1 are respectively mounted upon the sowing wheel shaft 12 and a driving shaft 16 journalled upon the frame 3 and driven from axle 2 by chain drive 17 and chain wheels 18, 18^1.

Attached to each wheel casing 8 is a feeding hopper 19 for the seed which leaves by a duct 20 to between the wheel 13 and casing 8. To the under side of the housing is fixed a furrowing tool 21 and also a shoe 22 upon a chain 23 serving to cover over the seed trench.

The sowing wheel casing 8 is strengthened at its periphery by a ring 24 which enables the thin iron casing to retain its form without the use of clips, and near the lowest point is an aperture 25 for the discharge of the seed. The wheel 13 running within the casing is built as a bucket wheel, the cells or buckets being formed by a disk 26 fast upon shaft 12, partitions 27 and a ring 29, and also has a partition 28 adapted to shut off a portion of the inner circumference. Disk 26 and ring 29 converge towards their outer edges to facilitate the depositing of the seeds. The partitions 27 are, as shown in Fig. 7, each provided with a spoon-like portion 27^1 conforming to the shape of a single seed, which in this case is of longish shape, but for round seeds would be practically hemispherical. To assist in the introduction of a seed of this elongated shape the cell walls 27 are each provided with a recessed portion 27^{11}. The partition 28 is adjustable concentrically of the axle 12 by means of pin 28^1, fly-nut 28^{11} and slot 30 in the casing 26. Fig. 2 shows the partition in working position, the dot-dash lines showing the position for emptying the contents of the casing. A corrugated wheel 31 keyed upon shaft 12 within the casing serves to prevent

sticking of the seeds. A spring striker 32 fastened to the casing co-operates with the spoons 27^1 to assist in removing surplus seeds.

The arm 7 can be moved into operative or inoperative position (indicated by full and dot-dash lines respectively in Fig. 4) by means of lever 33 moving over quadrant 34 and connected to said arm by a chain 35. The supporting roller 11 (Fig. 2) may also be utilized as a furrower as shown in Figs. 5 and 6. In this case a sharp-edged disk 36 is rotatable upon an eccentric 37 of the axle 39 carried by the cheeks 38, 38^1 of the arm 7, the two rollers 40, 40^1 riding over the edges of the seed furrow produced by the disk 36. By slackening the securing bolts 41, 41^1, the position of the eccentric may be adjusted to give the desired depth of furrow by means of a key applied to the squared end 42 of the axle.

Fig. 5 shows the partition 28 somewhat modified from that shown in Fig. 2 and consists of a semi-cylindrical ring mounted upon the sowing wheel casing

The operation of the machine is as follows:

The arms 7 are placed in inoperative position by moving lever 33 over quadrant 34. The casings 8 are charged with seed from the supply box 4 by means of the slides 5, the partition 28 being in position as shown in Fig. 2. The position of the roller 11 or of the eccentric 37 is adjusted so that the furrowing tool 21 presses more or less deep in the earth as desired. Upon moving the machine forward by animal or mechanical traction, the lever 33 being in the position shown in Fig. 4, the sowing wheels are rotated in the direction indicated by arrow E by means of the chain drives 14, 17. In each casing the bucket partitions 27 abstract seed from the supply and the seed not retained by the spoons 27^1 falls back into the casing till, as shown in Fig. 2, the topmost cell carries only two seeds of which the upper is dislodged by the striker 32. The single seed thus retained by the spoon is then caused by gravity to fall against the circumferential wall of the casing and thus through the aperture 25 into the furrow prepared by the tool 21 and disk 36, being finally covered over by the shoe 22. According to the gear of the chain drives the spacing of the seeds in the rows may be different.

The emptying of the casings, after bringing them into inoperative or raised position, is effected by placing the partition 28 in the dot-dash position shown in Fig. 2.

Sh uld it be desired to sow the seeds in diamond formation i. e. alternately in adjacent rows, it is only necessary to displace adjacent sowing wheels relatively by half a cell space.

The above described sowing apparatus, being fitted with a supply box for the seed and a separate and complete sowing device for each row, can be used to sow rows of various arrangements and distances apart.

It is to be understood that I may employ any suitable type of furrow opening and covering mechanism in conjunction with the improved seed selecting and depositing means herein shown and described, though I prefer to employ the means herein illustrated.

I claim:

1. Machine for sowing seed comprising in combination a hopper, a bucket wheel rotatably mounted within a casing, a seed receptacle in communication with said hopper, an adjustable partition for separating a plurality of the buckets from the seeds in said seed receptacle and for emptying the seed receptacle.

2. Machine for sowing seed comprising in combination a hopper, a bucket wheel rotatably mounted within a casing consisting of a disc, an annulus and a plurality of radial partitions therebetween adjacent the periphery, the inner end of each partition being provided with a spoonlike device retaining a single seed and a recessed portion for guiding a single seed on said spoonlike device.

3. Machine for sowing seed comprising in combination a hopper, a bucket wheel rotatably mounted within a casing, a seed receptacle in communication with said hopper, means for gathering a plurality of seeds from said seed receptacle and retaining single seeds, and a spring actuated striker for removing surplus seeds.

4. In a machine of the character described the combination with a circular casing, of a bucket wheel rotatable therein and comprising a plurality of radial partitions the outer ends of which rotate in contact with said casing and the inner ends of which are spaced from each other to leave open passages through which seeds may pass from the inner periphery of the bucket wheel to the outer periphery thereof, the inner end of each partition being provided with a spoonlike seed retaining portion, an aperture in the lower part of said casing through which seeds are discharged, a partition within said casing forming the lower wall of the seed receptacle and means for adjusting the angle of inclination of said partition.

5. In a machine of the character described the combination with a circular casing, of a bucket wheel rotatable therein and comprising a plurality of radial partitions the inner ends of which are provided with spoonlik seed retaining portions, a seed compartment l cated within the interior of the bucket wheel, means for feeding seeds

into said compartment and means for adjusting the position of the bottom of said compartment.

6. A structure as recited in claim 5 wherein said adjusting means is controllable from the exterior of said compartment.

7. A structure as recited in claim 5 in combination with an agitator rotatable within the compartment and movable with the bucket wheel.

8. A structure as recited in claim 5 in combination with a movable bottom for the compartment, means adjusting said bottom from the exterior of the compartment, and an agitator rotatable within the compartment.

9. In a device of the character described the combination with a circular casing, of a bucket wheel mounted for rotation therein and comprising a pair of spaced annuli, a plurality of radial partitions, constituting buckets disposed between said annuli and passages between said partitions extending from the inner to the outer periphery of the bucket wheel, the space within the bucket wheel constituting a seed chamber, a seed hopper, means for conducting seed from the hopper to the seed compartment and a movable bottom for the seed compartment having a portion shaped to conform to the curvature of the inner periphery of the bucket wheel.

10. A structure as recited in claim 9, in combination with means for adjusting the position of the movable bottom from the exterior of the casing.

11. A structure as recited in claim 9, in combination with a centrally disposed drive shaft and a toothed agitator thereon.

12. A device of the character described comprising a circular casing, a bucket wheel in the form of an annulus, mounted for rotation therein and comprising a plurality of spaced buckets each having a seed carrying compartment and a yieldable element located inside of the bucket wheel and supported from the casing, the free end of which engages the inner ends of said buckets to snap past them as they rotate and thereby impart a series of blows to the bucket wheel to dislodge surplus seeds from the buckets.

GEORGE KÜHNE.